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VIEWS, NEWS AND INTERVIEWS.

A Philadelphia physician, Dr. G. Betton Massey, had devised an electrical treatment for cancer and the allied diseases, which is said to be very effective. Salts of mercury are driven into the diseased tissue by cataphoretic action. Of 10 operable cases it is claimed that eight were cured, one probably cured and one lost.

The Soudan is being rapidly covered with a network of telegraph wires. It is expected that the telegraph will be 1,000 miles south of Khartoum at the end of the year. This means the practical joining up with Uganda, and as Rhodes's telegraph is approaching Tanganyika the transcontinental telegraph may be expected to be finished early next year.

In observance of his 40th birthday and seventh year as manager of the Springfield, Ohio, Railway Company, Manager S. L. Nelson, a few days ago, made a money present to every employé of the company. Superintendent L. O. Wilson, who has assisted Manager Nelson for four years, received $150 in cash and a government bond for $100. Between $600 and $700 in gold was distributed.

A fair specimen of newspaper fiction comes from Ottawa, Can. The story goes that after the battle of Omdurman, in the Soudan, the surgeons needed current to recharge the batteries of their X-ray outfits. Having no engine, recourse was had to the next best thing. "The pulley of a small dynamo was connected by means of a leather strap with the rear wheel of a specially constructed tandem bicycle. The required velocity for the dynamos was thus obtained and our procedure was as follows: Having carefully adjusted the circuit with the storage battery, and also with the voltmeter and ammeter, a warrant officer took his position on the seat of the bicycle and commenced pedaling. When 15 volts and 14 amperes were registered the switch close to the handle of the bicycle was opened and the charging of the battery begun." What fine, strong warrant officers the British army must have! To drive a bicycle, bend a belt, overcome losses of all sorts, and still pedal out something more than one-fourth horse-power of current is an achievement worthy of the V. C.

A well known X-ray specialist, of New York, was bewailing his fate last Wednesday. "Here's the Fourth of

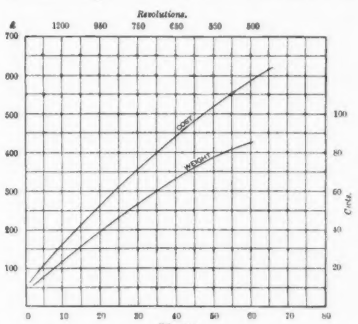


FIG. 1.—CURVES OF PRICE AND WEIGHT.

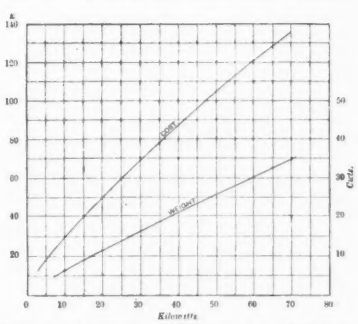


FIG. 2.—CURVES OF PRICE AND WEIGHT.

July gone," he said, "and some 13 or 14 people shot in Greater New York; but every solitary one was either killed outright or the bullet went through clear. I didn't get a case. How's that for hard luck?"

It has been estimated that the waterfalls in California alone have over 240,000 horse-power, and that about 45,000 of this power has already been converted into electrical energy and sent to Los Angeles, Sacramento, Fresno, Pomona, Redlands, Folsom and San Diego, for lighting and motive purposes. Five more electric companies will have their long-distance transmission systems in working order by next September. About 50,000 more horse-power will be developed by them for use in California and Oregon, while still other companies are beginning work on electric power plants that will cost from $100,000 to $500,000 each and will harness more mountain streams for electrical transmission of their power to distant towns.

The electrically heated cloth presses introduced some few years ago into the textile works of Europe are coming into increased use, and are found in every way superior to the old method where sheet-iron plates were heated in ovens, and then placed between the layers of cloth. The new

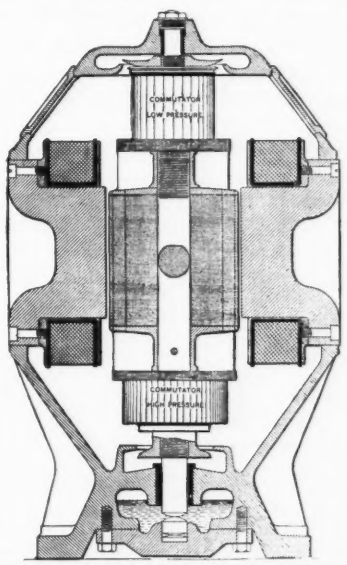


FIG. 3.—SCOTT'S VERTICAL HIGH-SPEED CONTINUOUS-CURRENT TRANSFORMER.

process is also somewhat more economical and as regards ease in manipulation and accuracy of adjustment is far more advantageous. The body of these electric press boards consists of a preparation of asbestos, which is covered by the wire which supplies the heat, and a layer of paper-pulp of some sort, the whole being between 5-32 and 5-64 of an inch in thickness. They are used by being placed at equal distances between the layers of the piece of cloth, which is laid between plates of sheet-iron. The boards are somewhat over a yard in length by 27 inches in breadth, and require two amperes current on a 110-volt circuit. They can be heated to any desired temperature, and the cloth is heated slowly and without inequalities, as occurred under the old system.

HIGH-SPEED CONTINUOUS-CURRENT TRANSFORMERS.*

BY ERNEST KILBURN SCOTT.

When comparing estimates of alternating and continuous current schemes, it will be found that the main difference in cost lies in the transforming apparatus. The curves given in Figs. 1 and 2 are averaged from actual prices, and go to show that continuous-current transformers cost about five times the price of alternating-current transformers of the same output. Thus, from the curve, it will be seen that, while a 50-kilowatt alternating-current transformer costs about $520, a 50-kilowatt continuous-current single-core machine, running at, say, 550 revolutions, costs $2,600.† There is thus a fair opening for some method of reducing the size, and, therefore, the price of the continuous-current transforming apparatus; and it appears to the writer that this can be best effected by increasing the speed of rotation.

When continuous-current transformers were first introduced they consisted of two ordinary two-pole dynamos coupled together. This method was soon improved upon by placing the two windings upon a single dynamo core, thus taking advantage of the armature reaction of one winding to neutralize that of the other, and in this way reduce the cost of the transformer considerably. In both cases, however, the ordinary standard two-pole dynamo carcase is employed, and the speed remains about the same as for ordinary belt-driven dynamos. For example:

1,200	revolutions	for 10	kilowatts,
950	"	20	"
750	"	30	"
550	"	50	"

and so on.

Experience fixed upon these speeds for dynamos, principally because they gave a convenient size of pulley, higher speeds giving too small a pulley for the belt to bend round con-

*The (London) *Electrician*.

†In comparing these prices, something must be allowed for the fact that there is less competition in the manufacture of continuous-current transformers, especially for high voltages, and consequently prices are high.

veniently or else too high a belt velocity. Now, a transformer being entirely self-contained, there is, first, no absolute necessity to rotate horizontally, and, second, having no pulley, there is no occasion to limit the speed, except from the point of strength of the piano-wire bindings (if the armature has such) and the proper performance of the bearings. If in sufficient quantity and of large enough section, piano wire will hold quite safely for peripheral speeds of 9,000 feet per minute; but by embedding the windings in tunnels in the armature core it is now possible to dispense with bindings altogether. With regard to the bearings, special ball bushes admit of the speeds being increased some 15 or 20 per cent with horizontal spindles; but ball-bearings have not proved such a success as was expected, partly on account of the noise and the lubrication. In any case, 15 or 20 per cent increase of speed is of little real use in reducing the price, and the writer therefore suggests that transformers should be run vertically, at about three or four times the present normal speeds.

Three or four thousand revolutions per minute is common practice for hydro-extractors and cream separators, and even for steam turbines working horizontally, so there should be no great difficulty in running up the speed of continuous-current transformers if proper precautions are taken. For example, a 30-kilowatt transformer, which ordinarily runs at 750 revolutions per minute, might be speeded up vertically to, say, 4,000 revolutions per minute. This would reduce the dimensions to about one-fourth, and the price might come down to about $600 instead of being $1,750. In other words, by increasing the speed rather over four times, the price per kilowatt for continuous-current transformers could be brought down to, say, $20 as against $12.50, which is the average price for an alternating-current transformer.

The construction of such a vertical transformer is indicated in Fig. 3, and it should be noted that there are several other advantages in such an arrangement; for example, a considerable saving in floor space is obtained. With alternating currents it is possible to pass so large a transformer as 40 kilowatts through a manhole 24 inches square, but unless the machine were completely dismantled it is extremely doubtful whether the ordinary continuous-current machine of only 10 kilowatts would go through so small a space. This is important from the point of view of sub-stations.

In this connection also it may be interesting to note that the saving in floor space would be specially convenient in the case of balancing transformers and boosters, as used in ordinary continuous-current three-wire stations. It is becoming usual nowadays to couple the balancing transformers of a three-wire system and the booster for either side of the middle wire all in one line, and as may be supposed such an arrangement covers a good deal of space; besides, the extreme length compared with the width is apt to set up unpleasant vibration. A double 16-kilowatt balancing transformer coupled to a 15-kilowatt booster will run out to as much as 14 feet long, while the width and height may be only 24 inches and 32 inches, respectively. If constructed as the writer suggests, the floor space would be probably reduced to three feet square. There is no doubt that the effort to use patterns in existing two-pole machines at every opportunity is responsible for some terribly crude work in English practice.

It might at first be supposed that putting the armature spindle on end would cause a good deal of friction and wear on the footstep bearing. This need not be so, however, as the footstep can be relieved of a considerable portion of the weight by the simple expedient of placing the armature core or cores out of center with the field magnets, so that directly the coils are excited there is a strong upward pull. It is common knowledge that the mere proximity of the flywheel of a Willans or Belliss engine causes the armature to be placed one-fourth inch or more out of center with its field magnets, so as to neutralize the end thrust, and the writer therefore feels sure that this effect could be utilized to efficiently relieve the weight on a footstep bearing.

Of course, a good many details would have to be varied from present practice, but they are all mechanical, and the writer sees no great difficulty in dealing with them. For instance, in order to reduce the height as much as possible where there are several armatures one above the other, the commutators might be made radial. The top bush could be of the self-lubricating graphite type, as used in America, whilst the footstep might be arranged with balls or conical rollers instead of the hard steel disks shown in Fig. 3.

[The figures of cost of machines given by Mr. Scott are the prevailing prices in Great Britain. In the diagrams the left-hand column of prices is in pounds sterling.—ED. ELECTRICAL REVIEW.]

Telephone News .....and Comment

The Home Telephone Company, of Baltimore, Md., has purchased the property at the northeast corner of Lexington and Courtland streets from the H. P. C. Wilson estate for $80,000, and will erect thereon a large office building.

The Chicago Telephone Company's new building will more than double the space which is now occupied by the main exchange. The new building will be eight stories, while the one now occupied is seven stories in height. The top story will be used for the main operating-room. There are 12 exchanges operated in Chicago, and also about 140 towns in the district surrounding the city.

The three largest telephone companies in the United States made a net gain of 5,470 subscribers in June.

	Gain.	Total Connected.
Central Union.....	607	52,745
Pacific Coast.....	1,134	54,330
Erie System.....	3,729	84,115
Total.....	5,470	191,190

Net gain for the six months has been as follows: Central Union, 7,440; Pacific Coast, 9,345; Erie system, 21,372; total, 38,157.

George W. Russell has filed a suit for $6,000 damages against the Sunset Telephone Company, Santa Barbara, Cal., for injuries which he claims to have received while trying to use one of the company's lines. Several weeks ago Russell was using a telephone, when in some way a magneto was turned on, and he alleges that he received a severe shock, from which he suffered a stroke of paralysis. At the time of the accident it was thought Russell was fatally injured, but he seems now to be completely recovered.

The instrument output statement of the American Bell Telephone Company for the month ending June 20, and the fiscal year to the same date, compares with the corresponding periods of 1898, as follows:

Month ending June 20:	1899.	1898.	Inc.
Gross output.....	61,399	23,975	37,428
Returned.....	15,668	9,650	6,018
Net output.....	45,731	14,321	31,410
Since December 20:			
Gross output.....	61,399	23,971	37,428
Returned.....	91,737	73,395	18,342
Net output.....	249,289	93,038	156,251
Total outst nding.....	1,374,175	1,012,159	362,016

The net output for the month ending June 20, amounting to 45,731, has been exceeded only twice in the history of the company; namely, 53,500 in March and 48,402 in April. For the past few months instrument orders have exceeded the ability of the company to supply by from 10,000 to 20,000 instruments per month. From now on it is expected that the usual Summer dullness will average up the production and demand.

General Manager Baker, of the Southwestern Telegraph and Telephone Company, states that long-distance service is interrupted at Columbus on the Southern Pacific Road, and at the Brazos River on the Houston & Texas Central Railway, and that on the main line of the Houston & Texas Central Railway about 41 miles of pole line is under water, but that good service is being rendered between North and South Texas via Austin and Palestine. The damage to the Southwestern Telegraph and Telephone Company will probably not exceed $5,000.

Canadian Electrical Association.

The ninth annual convention of the Canadian Electrical Association was held at Hamilton, Ont., on June 28, 29 and 30. There was a large attendance of gentlemen prominently connected with electrical interests in Canada. A local committee provided an attractive programme of entertainment, and Mayor Teetzel welcomed the delegates. President W. H. Browne occupied the chair. Numerous committee reports and the report of the secretary-treasurer were read.

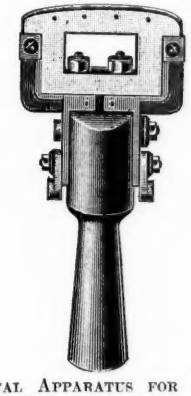
Among the papers presented were the following: "Meters and Meter Rates," by A. A. Dion; "Central Station Accounting from a Business Standpoint," by P. H. Hart; "The Protection of Low-Tension Wiring Against Dangerous High-Potential Currents," by W. J. Plews; "Transformer Economy," by F. H. Leonard, Jr.; "Long-Burning Enclosed Arc Lamps," by W. A. Turbayne, and "The Incandescent Lamp for Central Stations," by E. E. Cary.

Officers for the ensuing year were elected as follows: President, A. A. Dion, Ottawa; first vice-president, E. E. Cary, St. Catherines; second vice-president, P. G. Gossler, Montreal, Que. Executive Committee, J. W. Wright, Toronto; A. B. Smith, Toronto; O. Higman, Ottawa; George Black, Hamilton, and John Carroll, Montreal, Que.; D. R Sweet, Ottawa; A. Sangster, Sherbrooke; J. F. H. Wyse, Brantford; B. F. Reesor, Lindsay, and W. H. Browne, Montreal, Que. Secretary-treasurer, C. H. Mortimer, Toronto.

The next convention will be held at Ottawa.

Removal of Wool from Skins by Electricity.

A process has recently been patented by a Bradford, England, syndicate for removing wool from skins by means of an electrical apparatus. The invention originated with a Bradford lady, Mrs. S. L. Johnson, and consists of an electric cautery or fleshing knife in such a handy form that the wool may be shorn or cut from the skin rapidly, and without injury either to the wool or to the pelt, says our English namesake. The form of the apparatus, which is held by the hand, is shown in the accompanying illustration. Electric cables which pass through the handle, and which are not shown in the illustration, are connected to the two terminals and from thence the current is



ELECTRICAL APPARATUS FOR REMOVING WOOL FROM SKINS.

passed through a wire of platinum-iridium alloy, which is thus rendered incandescent. The wire is fastened to and supported by a highly refractory substance, specially made for the purpose, the current required being about 60 amperes at four volts. The method of removing the wool is simply to push the cautery along the surface of the skin. The red-hot knife —if it may be so called—immediately mows down the wool, and the only limit to the speed at which the work can be done is the deftness of the operator. The work is performed so quickly that the heat in no way injures either the skin or the wool. It is estimated that a girl, with a few hours' practice, would be equal to dewooling from eight to a dozen skins per hour, and the cost of the current is so exceedingly small—being estimated at the seventy-second of a cent an hour—as to be almost a negligible quantity. The advantages of this system of pulling will be obvious. The wool itself is not injured by lime, chemicals or any other objectionable influence; the mere singeing of the end of each fiber is, indeed, imperceptible, and might, possibly, be even found to be advantageous rather than otherwise. The skin, which presumably has been sun-dried in Australia or South America, immediately after the slaughtering of the sheep, is in itself in a more perfect condition for the tanner to deal with, and the cost of the process must work out at something very much less than any of the prevailing systems. It is estimated that, in any of the present methods, it costs eight cents per skin to wet down, lime stove, or sweat it into a condition for the puller, and the pulling wages range from 11 to 17 cents per dozen skins. The cost of the apparatus is a mere trifle, and it is obvious, therefore, that this invention promises to effect such an economy that it will, as stated above, practically amount to a revolution in method.

Fire at the Como Exhibition.

A special newspaper cable dispatch from Rome says that fire started in the building of the Electrical Exhibition at Como, Italy, on July 8 at 10 o'clock A. M., resulting in the total destruction of the exhibition. No lives were lost, but many exhibits and scientific records were burned, which can not be replaced. Many relics of Volta were lost notwithstanding the fact that they were contained in a receptable composed of solid masonry.

This exhibition was to commemorate the centennial of the discovery of the electric battery by Alessandro Volta, who was a native of Como. Among the many notable exhibits that were shown were a large number of relics of Volta, including much of his experimental apparatus.

The Future of Aluminum.

Mr. Henri Moissan, the eminent Parisian electro-metallurgist, is quoted as saying: "We must not be led, by finding that aluminum is not the perfect metal that we had supposed, into discouragement in regard to its value. A chemist of the bronze age, on studying for the first time the qualities of iron, would probably have concluded, from its ready corrosion, that it could never have any industrial value; yet iron has rendered good service to the world, and aluminum, which is even more abundant than iron, is far less subject to corrosion, and weighs, bulk for bulk, less than one-third as much, should certainly have a useful future before it."

REPORT OF THE COMMITTEE ON STANDARDIZATION.

SUBMITTED TO THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, BOSTON, JUNE 27, 1899.

FRANCIS B. CROCKER, chairman; CARY T. HUTCHINSON, A. E. KENNELLY, J. W. LIEB, JR., CHARLES P. STEINMETZ, LEWIS B. STILLWELL, ELIHU THOMSON.

(*Concluded from page 3.*)

11. The losses in synchronous machines are:

a. Bearing friction and windage. See Section 4.

b. Molecular magnetic friction and eddy currents in iron, copper and other metallic parts. These losses should be determined at open circuit of the machine at the rated speed and at the rated voltage, $+ I r$ in a synchronous generator, $- I r$ in a synchronous motor, where I = current in armature, r = armature resistance. It is undesirable to compute these losses from observations made at other speeds or voltages.

These losses may be determined either by driving the machine by a motor or by running it as a synchronous motor, and adjusting its fields so as to get minimum current input and measuring the input by wattmeter. The former is the preferable method, and in polyphase machines the latter method is liable to give erroneous results in consequence of unequal distribution of currents in the different circuits caused by inequalities of the impedance of connecting leads, etc.

c. Armature-resistance loss, which may be expressed by $p\ I^2\ r$; where r = resistance of one armature circuit or branch, I = the current in such armature circuit or branch, and p = the number of armature circuits or branches.

d. Load losses as defined in Section 7. While these losses can not well be determined individually, they may be considerable and, therefore, their joint influence should be determined by observation. This can be done by operating the machine on short circuit and at full-load current; that is, by determining what may be called the "short-circuit core loss." With the low field intensity and great lag of current existing in this case, the load losses are usually greatly exaggerated.

One-third of the short-circuit core loss may, as an approximation, and in the absence of more accurate information, be assumed as the load loss.

e. Collector-ring friction and contact resistance. These are generally negligible, except in machines of extremely low voltage.

f. Field excitation. In separately excited machines, the $I^2\ r$ of the field coils proper should be used. In self-exciting machines, however, the loss in the field rheostat should be included. See Section 6 *f*.

III. Synchronous commutating machines.

12. In synchronous converters, the power on the alternating-current side is to be measured with the current in phase with the terminal electro-motive force, unless otherwise specified.

13. In double-current generators, the efficiency of the machine should be determined as a direct-current generator in accordance with Section 6, and as an alternating-current generator in accordance with Section 11. The two values of efficiency may be different, and should be clearly distinguished.

14. In synchronous converters the losses should be determined when driving the machine by a motor. These losses are:

a. Bearing friction and windage. See Section 4.

b. Molecular magnetic friction and eddy currents in iron, copper and metallic parts. These losses should be determined at open circuit and at the rated terminal voltage, no allowance being made for the armature resistance, since the alternating and the direct currents flow in opposite directions.

c. Armature resistance. The loss in the armature is $q\ I^2\ r$, where I = direct-current in armature, r = armature resistance, and q a factor which is equal to 1.37 in single-phasers, 0.56 in three-phasers, 0.37 in quarter-phasers and 0.26 in six-phasers.

d. Load losses. The load losses should be determined in the same manner as described in Section 11 *d* with reference to the direct-current side.

e and *f*. Losses in commutator and collector friction and brush-contact resistance. See Sections 6 and 11.

g. Field excitation. In separately excited fields, the $I^2\ r$ loss in the field coils proper should be taken, while in shunt and series fields the rheostat loss should be included, except where fields and rheostats are intentionally modified to produce effects outside of the conversion of electric power, as for producing phase displacement for voltage control. In this case 25 per cent of the $I^2\ r$ loss in the field proper at non-inductive alternating circuit should be added as proper estimated allowance for normal rheostat losses. See Section 6 *f*.

15. Where two similar synchronous machines are available, their efficiency can be determined by operating one machine as a converter from direct to alternating, and the other as a converter from alternating to direct, connecting the alternating sides together, and measuring the difference between the direct-current input and the direct-current output. This process may be modified by returning the output of the second machine through two boosters into the first machine and measuring the losses. Another modification might be to supply the losses by an alternator between the two machines, using potential regulators.

IV. Rectifying machines or pulsating-current generators.

16. These include open-coil arc machines, constant-current rectifiers, constant-potential rectifiers.

The losses in open-coil arc machines are essentially the same as in Sections 6 to 9 (closed-coil commutating machines). In alternating-current rectifiers, however, the output must be measured by wattmeter and not by voltmeter and ammeter, since, owing to the pulsation of current and electro-motive force, a considerable discrepancy may exist between watts and volt-amperes, amounting to as much as 10 or 15 per cent.

17. In constant-current rectifiers, transforming from constant-potential alternating to constant direct current by means of constant-current transformers and rectifying commutators, the losses in the transformers are to be included in the efficiency and have to be measured when operating the rectifier, since in this case the losses are generally greater than when feeding an alternating secondary circuit. In constant-current transformers the load losses are usually larger than in constant-potential transformers and thus should not be neglected.

The most satisfactory method of determining the efficiency in rectifiers is to measure electric input and electric output by wattmeter. The input is usually not non-inductive, owing to a considerable phase displacement and to wave distortion. For this reason the apparent efficiency should also be considered, since it is usually much lower than the true efficiency. The power consumed by the synchronous motor or other source driving the rectifier should be included in the electric input.

V. Stationary induction apparatus.

18. Since the efficiency of induction apparatus depends upon the wave shape of electro-motive force, it should be referred to a sine wave of electro-motive force, except where expressly specified otherwise. The efficiency should be measured with non-inductive load, and at rated frequency, except where expressly specified otherwise. The losses are:

a. Molecular magnetic friction and eddy currents measured at open circuit and at rated voltage — Ir, where I = rated current, r = resistance of primary circuit.

b. Resistance losses, the sum of the $I^2\ r$ of primary and of secondary in a transformer, or of the two sections of the coil in the compensator or auto-transformer, where I = current in the coil or section of coil, r = resistance.

c. Load losses; i. e., eddy currents in the

iron and especially in the copper conductors, caused by the current. They should be measured by short-circuiting the secondary of the transformer and impressing upon the primary an electro-motive force sufficient to send full-load current through the transformer. The loss in the transformer under these conditions measured by wattmeter gives the load losses $+ I^2 r$ losses in both primary and secondary coils.

d. Losses due to the methods of cooling, as power consumed by the blower in air-blast transformers, and power consumed by the motor driving pumps in oil or water-cooled transformers. Where the same cooling apparatus supplies a number of transformers or is installed to supply future additions, allowance should be made therefor.

19. In potential regulators the efficiency should be taken at the maximum voltage for which the apparatus is designed, and with non-inductive load, unless otherwise specified.

VI. Rotary induction apparatus.

20. Owing to the existence of load losses and since the magnetic density in the induction motor under load changes in a complex manner, the efficiency should be determined by measuring the electric input by wattmeter and the mechanical output at the pulley, gear, coupling, etc.

21. The efficiency should be determined at the rated frequency and the input measured with sine waves of impressed electro-motive force.

22. The efficiency may be calculated from the apparent input, the power factor and the power output. The same applies to induction generators. Since phase displacement is inherent in induction machines, their apparent efficiency is also important.

23. In frequency changers (i. e., apparatus transforming from a polyphase system to an alternating system of different frequency, with or without a change in the number of phases) and phase converters (i. e., apparatus converting from an alternating system, usually single-phase, to another alternating system, usually polyphase, of the same frequency), the efficiency should also be determined by measuring both output and input.

VII. Transmission lines.

24. The efficiency of transmission lines should be measured with non-inductive load at the receiving end, with the rated receiving pressure and frequency; also with sinusoidal impressed electro-motive forces, except where expressly specified otherwise, and with the exclusion of transformers or other apparatus at the ends of the line.

RISE OF TEMPERATURE.

General principles.

25. Under regular service conditions the temperature of electrical machinery should never be allowed to remain at a point at which permanent deterioration of its insulating material takes place.

26. The rise of temperature should be referred to the standard conditions of a room-temperature of 25 degrees centigrade, a barometric pressure of 760 millimetres and normal conditions of ventilation; that is, the apparatus under test should neither be exposed to draught, nor enclosed, except where expressly specified.

27. If the room-temperature during the test differs from 25 degrees centigrade, the observed rise of temperature should be corrected by one-half per cent for each degree centigrade.* Thus, with a room-temperature of 35 degrees centigrade the observed rise of temperature has to be decreased by five per cent, and with a room-temperature of 15 degrees centigrade the observed rise of temperature has to be increased by five per cent. The thermometer indicating the room-temperature should be screened from thermal radiation emitted by heated bodies, or from draughts of air. When it is impracticable to secure normal conditions of ventilation, on account of an adjacent engine or other sources of heat, the thermometer for measuring the air temperature should be placed so as fairly to indicate the temperature which the machine would have if it were idle, in order that the rise of temperature determined shall be that caused by the operation of the machine.

28. The temperature should be measured after a run of sufficient duration to reach practical constancy. This is usually from 6 to 18 hours, according to the size and construction of the apparatus. It is permissible, however, to shorten the time of the test by running a lesser time on an overload in current and voltage, then reducing the load to normal, and maintaining it thus until the temperature has become constant.

In apparatus intended for intermittent service, as railway motors, starting rheostats, etc., the rise of temperature should be measured after a shorter time, depending upon the nature of the service, and should be specified.

In apparatus which, by the nature of their service, may be exposed to overload, as railway converters, and in very high voltage circuits a smaller rise of temperature should be specified than in apparatus not liable to overloads or in low-voltage apparatus. In apparatus built for conditions of limited space, as railway motors, a higher rise of temperature must be allowed.

29. In electrical conductors the rise of temperature should be determined by their increase of resistance. For this purpose the resistance may be measured either by galvanometer test or by drop-of-potential method. A temperature coefficient of 0.4 per cent per degree centigrade may be assumed for copper.† Temperature elevations measured in this way are usually in excess of temperature elevations measured by thermometers.

30. It is recommended that the following maximum values of temperature elevation should not be exceeded—

Commutating machines, rectifying machines and synchronous machines:

Field and armature, by resistance, 50 degrees centigrade.

Commutator and collector rings and brushes, by thermometer, 55 degrees centigrade.

Bearings and other parts of machine, by thermometer, 40 degrees centigrade.

Rotary-induction apparatus:

Electric circuits, 50 degrees centigrade, by resistance.

Bearings and other parts of the machine, 40 degrees centigrade, by thermometer.

In squirrel cage or short-circuited armatures, 55 degrees centigrade, by thermometer, may be allowed.

Transformers for continuous service—electric circuits by resistance, 50 degrees centigrade, other parts by thermometer, 40 degrees centigrade, under conditions of normal ventilation.

Reactive coils, induction and magneto regulators—electric circuits by resistance, 55 degrees centigrade, other parts by thermometer, 45 degrees centigrade.

Where a thermometer, applied to a coil or winding, indicates a higher temperature elevation than that shown by resistance measurement, the thermometer indication should be accepted. In using the thermometer, care should be taken so to protect its bulb as to prevent radiation from it, and, at the same time, not to interfere seriously with the normal radiation from the part to which it is applied.

31. In the case of apparatus intended for intermittent service, the temperature elevation, which is attained at the end of the period corresponding to the term of full load, should not exceed 50 degrees centigrade by resistance in electric circuits. In the case of transformers intended for intermittent service, or not operating continuously at full load, but continuously in circuit, as in the ordinary case of lighting transformers, the temperature elevation above the surrounding air-temperature should not exceed 50 degrees centigrade by resistance in electric circuits, and 40 degrees centigrade by thermometer in other parts, after the period corresponding to the term of full load. In this instance, the test load should not be applied until the transformer has been in circuit for a sufficient time to attain the temperature elevation due to core loss. With transformers for commercial lighting, the duration of the full-load test may be taken as three hours, unless otherwise specified. In the case of railway, crane and elevator motors the conditions of service are necessarily so varied that no specific period corresponding to the full-load term can be stated.

INSULATION.

32. The ohmic resistance of the insulation is of secondary importance only as compared with the dielectric strength, or resistance to rupture by high voltage.

Since the ohmic resistance of the insulation can be very greatly increased by baking, but the dielectric strength is liable to be weakened thereby, it is preferable to specify a high dielectric strength rather than a high insulation resistance. The high-voltage test for dielectric strength should always be applied.

Insulation resistance.

33. Insulation resistance tests should, if possible, be made at the pressure for which the apparatus is designed.

The insulation resistance of the complete apparatus must be such that the rated voltage of the apparatus will not send more than one one-millionth of the full load current, at the rated terminal voltage, through the insulation. Where the value found in this way exceeds one megohm, one megohm is sufficient.

Dielectric strength.

34. The dielectric strength or resistance to rupture should be determined by a continued application of an alternating electro-motive force for one minute. The source of alternating electro-motive force should be a transformer of such size that the charging current of the apparatus as a condenser does not exceed 25 per cent of the rated capacity of the transformer.

35 The high-voltage tests should not be applied when the insulation is low, owing to dirt or moisture, and should be applied before the machine is put into commercial service.

36. It should be pointed out that tests at high voltages considerably in excess of the normal voltages are admissible on new machines, to determine whether they fulfill their specifications, but should not be made subsequently at a voltage much exceeding the normal, as the actual insulation of the machine may be weakened by such tests.

37. The test for dielectric strength should be made with the completely assembled apparatus and not with its individual parts, and the voltage should be applied as follows:

1. Between electric circuits and surrounding conducting material, and,

2. Between adjacent electric circuits, where such exist, as in transformers.

The tests should be made with a sine wave of electro-motive force, or where this is not available, at a voltage giving the same striking distance between needle points in air, as a sine wave of the specified electro-motive force except where expressly specified otherwise. As needles, new sewing needles should be used. It is recommended to shunt the apparatus during the test by a spark gap of needle points set for a voltage exceeding the required voltage by 10 per cent.

Rated Terminal Voltage.	Capacity.	Testing Voltage.
Not exceeding 400 volts	Under 10 kilowatts	1,000 volts.
" " "	10 kilowatts and over	1,500 "
400 and over, but less than 800 volts	Under 10 kilowatts	1,500 "
400 " "	10 kilowatts and over	2,000 "
800 " " 1,200	Any	3,500 "
1,200 " " 2,500	Any	5,000 "
2,500 "	Any	Double the normal rated voltages
Synchronous motor fields and fields of converters started from the alternating-current side		5,000 volts.

A table of approximate sparking distances is given in Appendix V.

38. The following voltages are recommended for apparatus not including transmission lines or switchboards:

Alternator-field circuits should be tested under a breakdown test voltage corresponding to the rated voltage of the exciter, and referred to an output equal to the output of the alternator; i. e., the exciter should be rated for this test as having an output equal to that of the machine it excites.

Condensers should be tested at twice their rated voltage and at their rated frequency.

The values in the table above are effective values, or square roots of mean square, reduced to a sine wave of electro-motive force.

39. In testing insulation between different electric circuits as between primary and secondary transformers, the testing voltage must be chosen corresponding to the high-voltage circuit.

40. In transformers of from 10,000 volts to 20,000 volts it should be considered as sufficient to operate the transformer at twice its rated voltage by connecting first the one and then the other terminal of the high-voltage winding to the core and to the low-voltage winding. The test of dielectric resistance between the low-voltage winding and the core should be in accordance with the recommendation in Section 38 for similar voltages and capacities.

41. When machines or apparatus are to be operated in series, so as to employ the sum of their separate electro-motive forces, the voltage should be referred to this sum, except where the frames of the machines are separately insulated both from ground and from each other.

REGULATION.

42. The term regulation should have the same meaning as the term "inherent regulation," at present frequently used.

43. The regulation of an apparatus intended for the generation of constant potential, constant current, constant speed, etc., is to be measured by the maximum variation of potential, current, speed, etc., occurring within the range from full load to no load, under such constant conditions of operation as give the required full-load values, the condition of full load being considered in all cases as the normal condition of operation.

44. The regulation of an apparatus intended for the generation of a potential, current, speed, etc, varying in a definite manner between full load and no load, is to be measured by the maximum variation of potential, current, speed, etc., from the satisfied condition, under such constant conditions of operation as give the required full-load values.

If the manner in which the variation in potential, current, speed, etc., between full load and no load is not specified, it should be assumed to be a simple linear relation; i. e., undergoing uniform variation between full load and no load.

The regulation of an apparatus may, therefore, differ according to its qualification for use. Thus the regulation of a compound-wound generator specified as a constant-potential generator will be different from that it possesses when specified as an over-compounded generator.

45. The regulation is given in percentage of the full-load value of potential, current, speed, etc., and the apparatus should be steadily operated during the test under the same conditions as at full-load.

46. The regulation of generators is to be determined at constant speed; of alternating apparatus at constant impressed frequency.

47. The regulation of a generator-unit, consisting of a generator united with a prime mover, should be determined at constant conditions of the prime mover; i. e., constant steam pressure, head, etc. It would include the inherent speed variations of the prime mover. For this reason the regulation of a generator-unit is to be distinguished from the regulation of either the prime mover, or of the generator contained in it, when taken separately.

48. In apparatus generating, transforming or transmitting alternating currents, regulation should be understood to refer to non-inductive load; that is, to a load in which the current is in phase with the electro-motive force at the output side of the apparatus, except where expressly specified otherwise.

49. In alternating apparatus receiving

* This correction is also intended to compensate, as nearly as is at present practicable, for the error involved in the assumption of a constant temperature coefficient of resistivity; i. e., 0.4 per cent per degree centigrade taken with varying initial temperatures.

† By the formula $R_T = R_t\ (1 + 0.004\,\theta)$. Where R_t is the resistance at room-temperature, R_T the resistance when heated, and θ the temperature elevation (T-t) in degrees centigrade.

electric power, regulation should refer to a sine wave of electro-motive force, except where expressly specified otherwise.

50. In commutating machines, rectifying machines and synchronous machines, as direct-current generators and motors, alternating-current and polyphase generators, the regulation is to be determined under the following conditions:

a. At constant excitation in separately excited fields.

b. With constant resistance in shunt field circuits, and

c. With constant resistance shunting series fields; *i. e.*, the field adjustment should remain constant, and should be so chosen as to give the required full-load voltage at full-load current.

51. In constant-potential machines, the regulation is the ratio of the maximum difference of terminal voltage from the rated full-load value (occurring within the range from full load to open circuit) to the full-load terminal voltage.

52. In constant-current machines, the regulation is the ratio of the maximum difference of current from the rated full-load value (occurring within the range from full load to short-circuit) to the full-load current.

53. In constant-power machines, the regulation is the ratio of maximum difference of power from the rated full-load value (occurring within the range of operation specified) to the rated power.

54. In over-compounded machines, the regulation is the ratio of the maximum difference in voltage from a straight line connecting the no-load and full-load values of terminal voltage as function of the current to the full-load terminal voltage.

55. In constant-speed continuous-current motors, the regulation is the ratio of the maximum variation of speed from its full-load value (occurring within the range from full load to no load) to the full-load speed.

56. In transformers, the regulation is the ratio of the rise of secondary terminal voltage from full load to no load (at constant primary impressed terminal voltage) to the secondary terminal voltage.

57. In induction motors, the regulation is the ratio of the rise of speed from full load to no load (at constant impressed voltage) to the full-load speed.

The regulation of an induction motor is, therefore, not identical with the slip of the motor, which is the ratio of the drop in speed from sychronism to the synchronous speed.

58. In converters, dynamotors, motor-generators, and frequency changers, the regulation is the ratio of the maximum difference of terminal voltage at the output side from the rated full-load voltage (at constant impressed voltage and at constant frequency) to the full-load voltage on the output side.

59. In transmission lines, feeders, etc., the regulation is the ratio of maximum voltage difference at the receiving end, between no load and full non-inductive load, to the full-load voltage at the receiving end, with constant voltage impressed upon the sending end.

60. In steam engines, the regulation is the ratio of the maximum variation of speed in passing from full load to no load (at constant steam pressure at the throttle) to the full-load speed.

61. In a turbine or other water-motor the regulation is the ratio of the maximum variation of speed from full load to no load (at constant head of water; i. e., at constant difference of level between tail race and head race) to the full-load speed.

Variation and pulsation:

62. In prime-movers which do not give an absolutely uniform rate of rotation or speed, as in steam engines, the "variation" is the maximum angular displacement in position of the revolving member, expressed in degrees, from the position it would occupy with uniform rotation, and with one revolution as 360 degrees, and the pulsation is the ratio of the maximum change of speed in an engine cycle to the average speed.

63. In alternators or alternating-current circuits in general the variation is the maximum difference in phase of the generated wave of electro-motive force from a wave of absolutely constant frequency, expressed in degrees, and is due to the variation of the prime-mover. The pulsation is the ratio of the maximum change of frequency during an engine cycle to the average frequency.

64. If n = number of poles, the variation $\frac{n}{2}$ of an alternator is — times the variation of its prime-mover if direct-connected, and $-p\frac{n}{2}$ times the variation of the prime-mover if rigidly connected thereto in the velocity ratio p

65. The pulsation of an alternating-current circuit is the same as the pulsation of the prime-mover of its alternator.

RATING.

66. Both electrical and mechanical power should be expressed in kilowatts, except when otherwise specified. Alternating-current apparatus should be rated in kilowatts, on the basis of non-inductive condition; i.e., with the current in phase with the terminal voltage.

67. Thus the electric power generated by an alternating-current apparatus equals its rating only at non-inductive load; that is, when the current is in phase with the terminal voltage.

68. Apparent power should be expressed in kilovolt-amperes, as distinguished from real power in kilowatts.

69. If a power-factor other than 100 per cent is specified, the rating should be expressed in kilovolt-amperes and power-factor, at full load.

70. The full-load current of an electric generator is that current which with the rated full-load terminal voltage gives the rated kilowatts, but in alternating-current apparatus only at non-inductive load.

71. Thus in machines in which the full-load voltage differs from the no-load voltage, the full-load current should refer to the former.

If P = rating of an electric generator and E = full-load terminal voltage, the full-load current is:

$I = \frac{P}{E}$ in a continuous-current machine or single-phase alternator.

$I = \frac{P}{E\sqrt{3}}$ in a three-phase alternator.

$I = \frac{P}{2E}$ in a quarter-phase alternator.

72. Constant-current machines, such as series arc-light generators, should be rated in kilowatts based on terminal volts and amperes at full load.

73. The rating of a fuse or circuit-breaker should be the current strength at which it will open the circuit, and not the working-current strength.

Classification of voltages and frequencies.

74. In direct-current low-tension generators, the following average terminal voltages are in general use and are recommended:

125 volts. 250 volts. 550 volts.

75. In direct-current, and alternating-current, low-pressure circuits, the following average terminal voltages are in general use and are recommended:

110 volts. 220 volts.

In direct-current power circuits, for railway and other service, 500 volts may be considered as standard.

76. In alternating-current, high-pressure circuits at the receiving end, the following pressures are in general use and are recommended:

1,000 volts. 2,000 volts. 3,000 volts.
6,000 volts. 10,000 volts.
15,000 volts. 20,000 volts.

77. In alternating-current, high-pressure generators or generating systems, the following terminal voltages are in general use and are recommended:

1,150 volts. 2,300 volts. 3,450 volts.

These pressures allow of a maximum drop in transmission of 15 per cent of the pressure at the receiving end. If the drop required is greater than 15 per cent, the generator should be considered as special.

78. In alternating-current circuits, the following approximate frequencies are recommended as desirable:

25 ~ or 30 ~ 40 ~ 60 ~ 120 ~ *

*The frequency of 120~ may be considered as covering the already existing commercial frequencies between 120~ and 140~, and the frequency of 60~ as covering the already existing commercial frequencies between 60~ and 70~.

These frequencies are already in extensive use and it is deemed advisable to adhere to them as closely as possible.

Overload capacities:

79. All guarantees on heating, regulation, sparking, etc., should apply to the rated load, except where expressly specified otherwise, and in alternating-current apparatus to the current in phase with the terminal electro-motive force, except where a phase displacement is inherent in the apparatus.

80. All apparatus should be able to carry a reasonable overload without self-destruction by heating, sparking, mechanical weakness, etc., and with an increase of temperature elevation not exceeding 15 degrees centigrade, above those specified for full loads. See Sections 25 to 31.

81. Overload guarantees should refer to normal conditions of operation regarding speed, frequency, voltage, etc., and to non-inductive conditions in alternating apparatus, except where a phase displacement is inherent in the apparatus.

82. The following overload capacities are recommended:

1. In direct-current generators and alternating-current generators, 25 per cent for one-half hour.

2. In direct-current motors and synchronous motors, 25 per cent for one-half hour, 50 per cent for one minute—except in railway motors and other apparatus intended for intermittent service.

3. Induction motors, 25 per cent for one-half hour, 50 per cent for one minute.

4. Synchronous converters, 50 per cent for one-half hour.

5. Transformers, 25 per cent for one-half hour—except in transformers connected to apparatus for which a different overload is guaranteed, in which case the same guarantees shall apply for the transformers as for the apparatus connected thereto.

6. Exciters of alternators and other synchronous machines, 10 per cent more overload than is required for the excitation of the synchronous machine at its guaranteed overload, and for the same period of time.

APPENDIX I.

EFFICIENCY.

Efficiency of phase-displacing apparatus:

In apparatus producing phase displacement; as for example, synchronous compensators, exciters of induction generators, reactive coils, condensers, polarization cells, etc., the efficiency should be understood to be the ratio of the volt-ampere activity to the volt-ampere activity plus power loss.

The efficiency may be calculated by determining the losses individually, adding to them the volt-ampere activity, and then dividing the volt-ampere activity by the sum.

1. In synchronous compensators and exciters of induction generators, the determination of losses is the same as in other synchronous machines under Sections 10 and 11.

2. In reactive coils the losses are molecular friction, eddy losses, and I^2r loss. They should be measured by wattmeter. The efficiency of reactive coils should be determined with a sine wave of impressed electro-motive force, except where expressly specified otherwise.

3. In condensers, the losses are due to dielectric hysteresis and leakage, and should be determined by wattmeter with a sine wave of electro-motive force.

4. In polarization cells, the losses are those due to electric resistivity and a loss in the electrolyte of the nature of chemical hysteresis, and are usually very considerable. They depend upon the frequency, voltage and temperature, and should be determined with a sine wave of impressed electro-motive force, except where expressly specified otherwise.

APPENDIX II.

Apparent efficiency:

In apparatus in which a phase displacement is inherent to their operation, apparent efficiency should be understood as the ratio of net power output to volt-ampere input.

Such apparatus comprise induction motors, reactive synchronous converters, synchronous converters controlling the voltage of an alternating-current system, self-exciting synchronous motors, potential regulators, and open magnetic circuit transformers, etc.

Since the apparent efficiency of apparatus generating electric power depends upon the power factor of the load, the apparent efficiency, unless otherwise specified, should be referred to a load power-factor of unity.

APPENDIX III.

Power factor and inductance factor

The power factor in alternating circuits or apparatus may be defined as the ratio of the electric power, in watts, to volt-amperes.

The inductance factor is to be considered as the ratio of wattless volt-amperes to total volt-amperes.

Thus, if p = power factor, q = inductance factor, then $p^2 + q^2 = 1$.

The power factor is the

$$\frac{\text{(energy component of current or E. M. F.)}}{\text{(total current or E. M. F.)}}$$

and the inductance factor is the

$$\frac{\text{(wattless component of current or E. M. F.)}}{\text{(total current or E. M. F.)}}$$

$$= \frac{\text{true power}}{\text{volt amperes.}}$$

Since the power factor of apparatus supplying electric power depends upon the power factor of the load, the power factor of the load should be considered as unity, unless otherwise specified.

APPENDIX IV.

The following notation is recommended

E *e*, voltage, electro-motive force, potential difference.

I *i*, current.

P, power.

Φ, magnetic flux.

β, magnetic density.

R *r*, resistance.

X *x*, reactance.

Z *z*, impedance.

L *l*, inductance.

C *c*, capacity.

Vector quantities when used should be denoted by capital italics.

APPENDIX V.

Table of sparking distance in air between opposed sharp needle-points, for various effective sinusoidal voltages, in inches and in centimetres.

Kilovolts Square Root of Mean Square.	Distance. Inches.	Cms.
5	0.225	0.57
10	0.47	1.19
15	0.725	1.84
20	1.0	2.54
25	1.3	3.3
30	1.625	4.1
35	2.0	5.1
40	2.45	6.2
45	2 95	7.5
50	3.55	9.0
60	4.65	11.8
70	5.85	14.9
80	7.1	18.0
90	8.35	21.2
100	9.6	24.4
110	10 75	27.3
120	11.85	30 1
130	12.95	32.9
140	13.95	35.4
150	15.0	38.1

The city trustees of Santa Ana, Cal., have granted an electric lighting franchise to Belmont Perry, who in his bid offered free light to the city hall, public library and jail. Mr. Perry offered also to expend, in the ensuing six months, $10,000 on the construction of the system.

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CHARLES W. PRICE, - - - - - - EDITOR.
STEPHEN L. COLES, - - MANAGING EDITOR.
CHARLES T. CHILD, - - TECHNICAL EDITOR.
STEPHEN H. GODDARD, ADVERTISING MANAGER.

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Times Building, 41 Park Row.

WESTERN OFFICE:
FRANK E. COLBERT, REPRESENTATIVE,
960-965 Old Colony Building, Chicago.

WASHINGTON OFFICE:
GEO. C. MAYNARD, - REPRESENTATIVE,
800 H Street, N. W., WASHINGTON, D. C.

LONDON OFFICE:
HENRY W. HALL, - - REPRESENTATIVE,
42 Old Broad Street, LONDON, E. C.
News, Subscriptions and Advertisements.

SPECIAL NOTICE TO ADVERTISERS.

CHANGES for advertisements must be in this office by Friday noon for the following week's issue. NEW ADVERTISEMENTS should be in the office not later than Saturday noon to insure publication the following week, although it is occasionally possible to get in matter received on Monday.

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A NATIONAL AUTOMOBILE ASSOCIATION.

The time is ripe for the organization of a national association of those interested in automobiles and automobilism. The legal rights of these vehicles have been assailed by police and park boards, their status is indefinite and unsatisfactory, and united action is requisite for the enfranchisement of the machine and the betterment of many conditions surrounding the industry.

To-day the self-propelled vehicle—whether electromobile, or oil-driven or other machine for country use—stands in the same position that the electric light and the electric street railway occupied in 1884 and 1887, respectively; its coming is opportune and its future is big with promise, but its novelty and unfamiliarity work to its disadvantage. Both makers and users of the automobile fully recognize the need for a strong organization to protect and strengthen the new industry. Already the ELECTRICAL REVIEW has received suggestions regarding this matter. In view of them, considering what the Automobile Club de France has done for automobilism in that country, and what the National Electric Light Association and the American Street Railway Association have accomplished for the industries they represent in this country, it is urged that makers and users of automobiles meet to form an organization along somewhat similar lines. The vital importance of this matter can not be overestimated, for the automobile is to-day taking only the first step in the vast and revolutionary progress to which it is destined. The ELECTRICAL REVIEW will be glad to publish suggestions as to the time and place for the proposed convention. We believe that the first week in September and New York city will meet with general approval.

MUNICIPAL MADNESS.

On another page of this issue is an abstract of Mr. Samuel Insull's caustic analysis of the affairs of the Detroit municipal electric lighting station. It is a convincing refutation of the claims so often put forward by municipal agitators—bringing the cold light of fact to bear upon the somewhat dark and muddled situation in which this finest of American municipal stations finds itself.

The history of municipal ownership in this country is deeply interesting. The underlying argument of the municipal socialist is that if a private corporation can make a profit in public service it must necessarily be charging the taxpayers more than the service costs; *ergo*, why not "municipalize" the service and save the difference? This would be an irrefutable argument if it were possible to attain the same economy in municipal operation as is usual in private management. But this seems to be impossible, and, in the case of electric lighting plants, for two reasons. In the first place, purely political considerations prevent the municipal plant from going into the market for labor and making the best bargain for service. It is generally demanded that public servants be well paid. In the second place, it is illogical in the extreme to operate such a plant for profit. If it supplies private lights and makes a profit from them then the citizens using light pay more than their share of taxation. If it supplies such lights at a loss then the whole non-light-using community is taxed for the benefit of its customers. Obviously, then, the sole function of a municipal plant is public lighting. But if the station has to bear the costs of wires, conduits, buildings, poles, etc., which it must maintain in the streets precisely as if it enjoyed a profitable private lighting business, and must charge all this expense to street lighting solely, then it is evident that it can not compete with a private plant engaged in general lighting.

In Detroit these difficulties faced the commission having charge of the plant from the beginning. The municipal lighting scheme was conceived by demagogues, operated to show the truth of fallacious theories, and has left the city of Detroit very much in the position of the unfortunate hunter who caught the bear by the tail. It has its plant but it would like to let go.

To make a good showing the management of the Detroit installation resorted to the most obvious methods; they ground down the employés by an evasion of the eight-hour law, and they omitted to charge depreciation, sinking fund, relinquished taxes, and other such items against operation costs. Mr. Insull shows the whole state of the case. It is an impressive object lesson; it ought to be a well heeded warning.

On another page is a short paper, by Mr. Ernest Kilburn Scott, which makes a strong plea for a vertical-shaft design and high speed of operation for direct-current transformers. A great part of the argument is equally applicable to other forms of electrical machinery, perhaps most notably to the synchronous converter. In this machine, as in that described by Mr. Scott, there is no stress upon the bearings save that due to the weight of the revolving parts. The vertical construction seems to have every advantage, for it would save floor space, bring the commutator—in this class of machines relatively very large—to the top, where it could be easily looked after, and, by permitting the machine to run at a higher speed, reduce the number of its poles, its size, and its cost. These are exceedingly substantial advantages, and designers of synchronous converters would do well to consider them.

There is a very striking feature about the group of members of the American Institute of Electrical Engineers which appeared in the last issue of the ELECTRICAL REVIEW; the youth of the members is so apparent. Electrical engineering is distinctly a young man's profession. It is probable that the average age of the Institute members is under rather than over 35, and to this is due, doubtless, much of the energy displayed by individual members of the profession in the United States.

PERSONAL.

Lieut. W. R. King, U. S. N., has been elected president of the Polytechnic Institute, of Baltimore, Md.

Mr. J. J. Carty, chief engineer of the New York Telephone Company, is spending a vacation on the Maine coast.

Dr. Charles F. Brush, of Cleveland, has received the degree of S. M. from the University of Michigan, from which he was graduated.

Mr. C. C. Warren, president of the Warren Electric Manufacturing Company, Sandusky, Ohio, has recently completed the construction of a modern cruising yacht—a 40 footer—and will spend the Summer cruising through the Great Lakes with a party of guests.

Mr. H. R. Wellman, who has been the electrical engineer for the Armitage–Herschell Company, of North Tonawanda, N. Y., for some three years, has recently resigned his connection and will fill a similar position with the General Incandescent Arc Light Company, of New York.

Mr. Chas. G. Burton has accepted a position with the Chicago office of the Westinghouse Electric and Manufacturing Company. Mr. Burton has had an active electrical career, having originally been with the Brush interests and later with the Central Electric Company, of Chicago, and the Sprague Electric Company, at Chicago.

Mr. Ira A. McCormack has been appointed general superintendent in charge of operation and Mr. J. C. Brackenridge chief engineer in charge of maintenance of way, buildings and construction of the Prospect Park & Coney Island Railroad Company, which has been leased to the Brooklyn Heights Railroad Company, of Brooklyn, N. Y.

Electromobiles Ruled Out of New York's Central Park.

President Clausen, of the New York Park Board, has rejected the first application made to the Park Department by an owner or driver of an electromobile to enter Central Park. The application, Secretary Willis Holly said, was made by letter several days ago, and Mr. Clausen had had it under consideration since. In his reply to the application President Clausen said, that in his opinion, the time had not arrived when electromobiles should be allowed to drive through Central Park, which was about the only place in the city for pleasure riding. The presence of the machine carriages would frighten horses and the noise would destroy the harmony of the park. He added that he supposed the time would come when electromobiles would enter the park as well as every other public highway.

It is said that the applicant for the privilege was the owner of a private electromobile.

To Make Deep-Sea Cable.

The Standard Underground Cable Company, of Pittsburgh, according to the *Wall Street Journal*, will remove its plant to Perth Amboy, N. J., where it will engage in the manufacture of deep-sea cables. The company has recently increased its capitalization from $1,000,000 to $1,500,000. The proposed new plant will cost $250,000.

Electromobiles in New England.

The New England Electric Vehicle Transportation Company, of Boston, now has five electric cabs in operation in Boston and 12 open vehicles in operation at Newport, R. I. The company expects to have its station in the Cyclorama Building, in Boston, completed by August 1, by which time it will have 30 electric cabs in operation in that city, and will have 30 open vehicles in operation at Newport. The cabs now in service are in constant use. They are in great demand by physicians for the removal of convalescents.

The company will place in commission a system of delivery wagons in the Fall.

Electromobile Watering Carts in Paris.

Paris is to have a new sensation. The Municipal Council has hit upon a novel scheme for Summer comfort. An electromobile watering cart has been invented, which seems to be perfection in its way, and the Council will adopt it forthwith.

The vehicle has been experimented with on the Place de l'Hotel de Ville, and answers its purpose admirably. It is provided with a large tank, from which the water is ejected, not in a stream, but in a fine spray, and with a mechanical brushing apparatus. The motor is situated in front of the vehicle. It is proposed to build at once 300 of these carts, which will, it appears, suffice to keep the streets clean and cool and will replace the 800 horse-drawn vehicles and the innumerable officials of the hose, who are employed now for the work, and do it very badly.

Stanley Electric Manufacturing Company Sold?

It was reported in Wall street on July 11 that the Stanley Electric Manufacturing Company, of Pittsfield, Mass., had been sold to "a New York company." The capital of the Stanley company is $500,000, and it is said to have paid six per cent dividends since its organization. The reported price for the Stanley stock is $150 per share.

OBITUARY.

Herbert Hinkley Brooks, general manager of the American Circular Loom Company and the Boston Electroduct Company, of Boston, died at the family homestead in West Medford, Mass., on July 9, of consumption. Mr. Brooks was widely known in electrical circles and had many friends in all sections of the United States. He returned a few months ago from an extended visit to the West Indies where he had gone in search of health. The benefit he derived was only temporary and his death, although in a sense expected, will come as a shock to the many who knew him. Mr. Brooks was not married, and leaves his mother and a brother to mourn his loss. His remains were cremated on July 11.

LATE NEWS.

The first regular electric train from the Manhattan end of the Bridge over the Fifth avenue branch of the Brooklyn, N. Y., Union Elevated Railroad to Coney Island was put in operation on July 10.

The large plant of the Beacon Lamp Company, at New Brunswick, N. J., was totally destroyed by fire early in the morning of July 4. The loss is about $25,000 and is partially insured. The origin of the fire is unknown.

The Third Avenue Railroad Company, of New York city, has filed plans for its new two-story powerhouse, to cost $1,000,000. The building is to be of steel skeleton construction, filled in with stone, and will occupy a plot 319 feet by 216 feet at the northeast corner of Ninth avenue and 216th street.

The Rockaway Electric Light and Improvement Company, of New Jersey, has been incorporated at Trenton, N. J., with a capital of $15,000. The company will install an engine and an alternating-current dynamo of 600 16-candle-power lamps capacity. Benjamin Blum, of 699 Broadway, New York city, is the owner of the street franchise and lighting contract. He also has the contract for the installation, which will be sub-let.

An Electromobile Builder Endorses a National Organization.

To the Editor of Electrical Review:

The writer feels that there should be a national association organized on the part of those interested in the development of this industry, for the purpose of protecting its interests and securing favorable legislation, as well as of procuring the repeal of obnoxious laws that may be now enforced or that may hereafter be attempted to be put in force against electromobiles.

Inasmuch as you have the honor of having inspired the formation of the National Electric Light Association, your progressiveness and insight may determine a successful method of bringing into existence an organization as above suggested. The writer believes that such an organization would be more successfully launched by some one outside of those interested in the manufacturing end of the industry.

C. E. Corrigan,
General Manager, American Electric Vehicle Company, Chicago.
July 7.

No Strike on the Metropolitan Street Railway.

The rumors of a strike on the lines of the Metropolitan Street Railway Company, of New York city, which had been circulated in various newspapers, were set at rest last Monday morning when a committee of employés, representing 95 per cent of the men employed, called upon President Vreeland. The spokesman said:

"These 18 employés, representing the thousands employed by you, whose names are subscribed on the different papers that they have brought to you, state that they are perfectly satisfied with the hours, pay and management they are working under, and it is just as easy for an outside party to tie this road up as for a man to tie a knot in a cup of water."

A Correction.

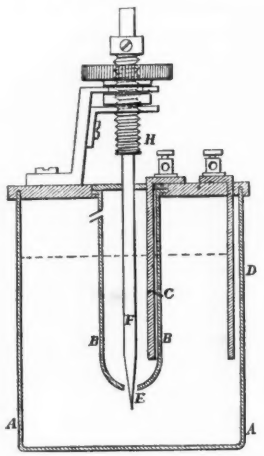
The article on "The Electrolytic Chlorate Works at Chedde, Savoy," by John B. C. Kershaw, which appeared in the Electrical Review for July 5, 1899, should have been credited to the *Engineering and Mining Journal*, through whose courtesy it appeared in these columns. The Electrical Review regrets the oversight and can only ascribe it to the stress of circumstances incident to the Fourth of July holidays. The incident is annoying to the Electrical Review as it is always particular in giving credit to whom credit is due.

SCIENCE BREVITIES.

Measurement of Alternate-Current Frequency—Herr W. König has described, in *Elektrotechnische Zeitschrift*, his improved method of measuring the frequency of an alternating current with the tuning-fork. To one prong of a tuning-fork he attaches a thin brass wire, serving as a recording stylus, while the foot of the tuning-fork is connected with one terminal of the circuit, the other terminal being connected with a metallic plate coated with a thin layer of asphalt lacquer. The fork is struck and placed above the plate, with the brass wire just touching. Either the plate or the fork is moved, mechanically or by hand, and the wire leaves a fine wavy trace on the plate. On sprinkling the plate with a mixture of flowers of sulphur and red lead, the wave-trace shows alternate yellow and red tracts, according to the sign of the current at the time. An examination of the number of tuning-fork vibrations contained in each tract gives the frequency of the current in terms of the pitch of the fork, which, of course, is absolutely constant. Supposing, for instance, that the fork has a pitch of 435 complete vibrations per second, and that one cycle covers nine of these. Then the number of alternations in the circuit is two (435 ÷ 9). For alternate current of 120 volts the traces are very sharp, but at low voltages they become indistinct, and they disappear at about eight volts. But above that limit the method is very handy and quite reliable.

Accumulator Traction—In a paper recently read by Dr. Seig before a society in Cologne, and reprinted in a French contemporary, the author describes the small line at Bremerhaven, which has a length of 2.7 miles. There are four motor cars and two trailers in use, the former holding 40 passengers, and weighing, empty, seven tons; the total weight of the batteries and passengers is 12 tons; each car has two series of motors of 10 horse-power, working with a reduction of one to four, and they are connected in series or parallel. The batteries are intended for a three hours' run; each battery consists of 86 cells, weighing, complete, 62 pounds. A single charge suffices for a run of 37 miles, although a run of 62 miles was made under favorable circumstances; the accumulators are recharged, however, for a run of about 28 to 32 miles. The charging station also contains a small storage battery plant for charging at night when the machinery is not running. From the detailed results of a two weeks' test it was found that the consumption of energy was about at the rate of 750 watt-hours per car-mile delivered to the battery, and including current for six lamps of 16 candle-power.

An Adjustable Caldwell Interrupter—At a recent meeting of the Royal Society Mr. A. A. Campbell-Swinton presented a form of the Caldwell interrupter which was evolved from that described in the ELECTRICAL REVIEW of May 17. It is shown in



CAMPBELL-SWINTON'S FORM OF CALDWELL'S INTERRUPTER.

the annexed figure, and has an outer and an inner vessel A and B, both fitted with dilute sulphuric acid, and each containing a lead electrode C D of considerable area. At the bottom of the inner vessel which is practically a test tube of about one and one-fourth inches in diameter, is a hole E about one-eighth inch in diameter. The actual size of the opening can be varied by a taper glass rod F which passes through it, and which can be raised and lowered by a screw H. As the area of the annular aperture is decreased the frequency of interruption is increased, the note rising rapidly. The great merit of the apparatus is that it operates equally well with current in either direction, or with alternating current, and that it is not so liable to fatigue as that of Wehnelt. It is capable of very fine adjustment.

Stereoscopic X-Ray Apparatus—A remarkably ingenious and interesting apparatus for use in X-ray work was presented to a recent Royal Society soirée by Mr. Mackenzie Davidson. The object was to give a stereoscopic image on a fluorescent screen of the part of the human body under examination. Supposing, for instance, that a hand having a bullet in it be placed before the screen in his apparatus, the bullet is seen among the bones and muscles just as if these were transparent, and a surgeon viewing it can describe its position in anatomical terms in such a way that another surgeon can cut down upon it. The observer has before him an opaque rotating disk in which two curved circumferential slots are cut, one in front of his left eye and one in front of his right. These slots are on opposite edges of the disk, so that first one eye is occulted and then the other, the spectator, therefore, being able to use only one eye at a time. The speed of rotation is, however, so rapid that the vision persists in both eyes. There are two X-ray tubes, about three inches apart, each illuminated by a coil having a mechanically-driven contact-breaker. These contact-breakers act alternately, one breaking contact as the left eye is uncovered by its slot, and the other doing the same for the right eye, the contact-breakers and the disk being driven by the same electric motor, and therefore acting in synchronism. The sequence of the parts of the apparatus is thus: First, two tubes side by side; second, the object to be viewed, say, a hand; third, the fluorescent screen; fourth, the rotating disk, with the segmental sight slots; fifth, the observer's eyes. When the right eye comes into operation it sees the object illuminated by the right X-ray tube for a fraction of a second. At the end of that period the vision is cut off by the disk and the tube extinguished. Rather more than one-fourth of a revolution of the disk uncovers the left eye, and at the same instant the left tube lights up, illuminating the object from that side, and so on. But, the intervals are so short that the vision persists in both eyes, the result being that the hand is seen is perspective, projected in the air just as if it were real, the only difference being that it can be seen through, the bones showing dark in the lighter colored flesh. By means of a switch the relation between the tubes and the eyes can be reversed, the left-hand tube being then made to light the object for the right eye, and vice versa. The effect of this is, as is well known, to appear to turn the object over. For instance, if a hand seen with one arrangement appears to have the palm turned towards the observer, immediately the switch is moved it appears to have the back towards him. This invention seems to be just what was needed to render the X-rays thoroughly useful for hospital work.

A Test for Lamp Vacua—An interesting note in *L'Electricien* describes a phenomenon observed by M. Ernest Gérard, and which may be applied as a simple and easy test for incandescent lamp vacua. If the lamp is held in the hand and lightly rubbed with a catskin, or even with the hand, in a perfectly dark place, fugitive flashes of light are seen in its interior. If the vacuum is very high these flashes will not be noticed. The effect is, of course, similar to that noticed over 200 years ago by Haukesbee in a mercurial barometer, and is due to the discharge of the lamp considered as a condenser, its inner surface being the filament and the outer surface the catskin or other rubbing surface. The phenomenon forms a very simple and easily applied test for lamp vacua.

Long-Distance Wireless Telegraphy—The French naval authorities, acting in conjunction with Mr. Marconi, on June 17, conducted some successful experiments with wireless telegraphy between a ship and the shore in the English Channel. The French storeship "Vienne" was used for the purpose. One of Mr. Marconi's installations was fitted up on board, and the inventor was present. Wimereaux, near Boulogne, and the South Foreland lighthouse, on the Kentish coast, were used as the land stations. Up to June 17 the distance between the South Foreland and Boulogne, about 28 miles, was the greatest space through which the messages have been transmitted. On June 17 messages were sent between the vessel and the English coast from off Boulogne, and afterwards at intervals, until the vessel was 12 or 14 miles away from that port. The greatest distance through which the messages were telegraphed was 42 miles. The increased distance appeared to have no effect, the messages being recorded at the receiving station at the South Foreland with unvarying distinctness. The experiments began at 8 A. M., and were continued throughout the day. In the afternoon the channel was enveloped in a dense fog, but this did not in any way interfere with the transmission of the messages. The vessel was fitted up with a wire passing up the masthead, and messages were exchanged while the vessel was traveling at various conditions of speed with the same result. An interesting feature in the experiments was the facility with which Marconi's latest development for cutting out a station was applied. The messages were sent at will either to Wimereaux or to South Foreland, without the other station being able to intercept them. The results of the experiments are to be reported to the French government.

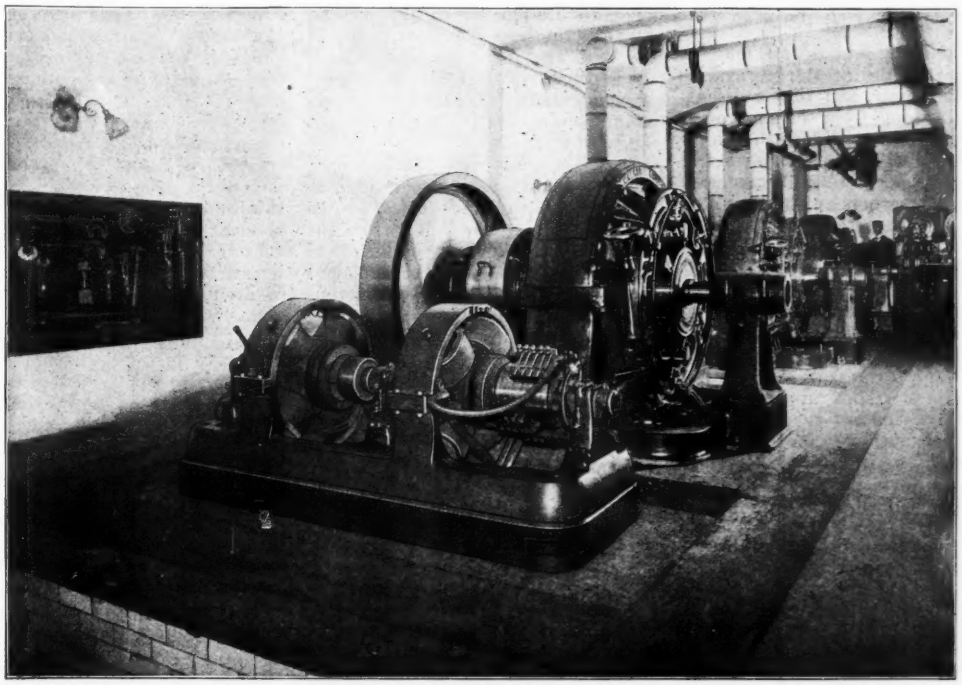
Accumulator Installation in the Dun Building, New York City.

The Dun Building, at the corner of Broadway and Reade street, New York, which was only recently completed, contains a highly modern installation for electrical distribution. This consists of three generating units, each composed of a 100-kilowatt, 250-volt dynamo, direct-coupled to a steam engine, and running at 250 revolutions per minute, a booster and a storage battery. The illustration shows the three generating units and the booster, which is of the constant-current type, having a capacity of 180 amperes and 50 volts. It is driven by a shunt motor running directly off the bus-bars.

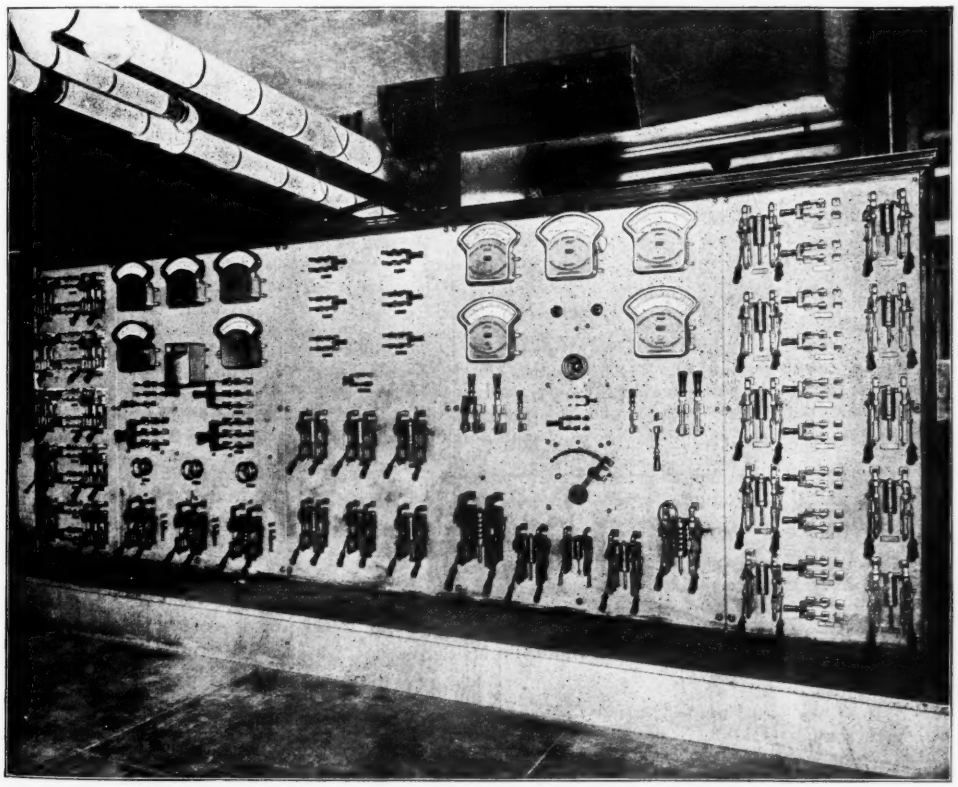
The peculiarity of this installation is that the elevators, six in number, the lighting and the various power circuits about the building are driven from the same general bus-bars. The load curve, which is reproduced herewith, is exceedingly irregular on account of the sudden and large demands for current made by the elevators. The time over which the curve extends is less than 15 minutes, and it will be seen that the use of the storage battery has left the fluctuations of the generator current relatively unimportant during this period.

The switchboard is on the other side of the generator room and parallel to the line of dynamos, and is well shown in one of the accompanying illustrations. It consists of five white marble panels, the end ones containing the switches and circuit breakers for operating the lighting circuits. The second panel from the left is for the generators. The corresponding panel on the other side contains the instruments for governing the battery and booster, while the center panel contains the cut-outs, etc., for the six elevator circuits.

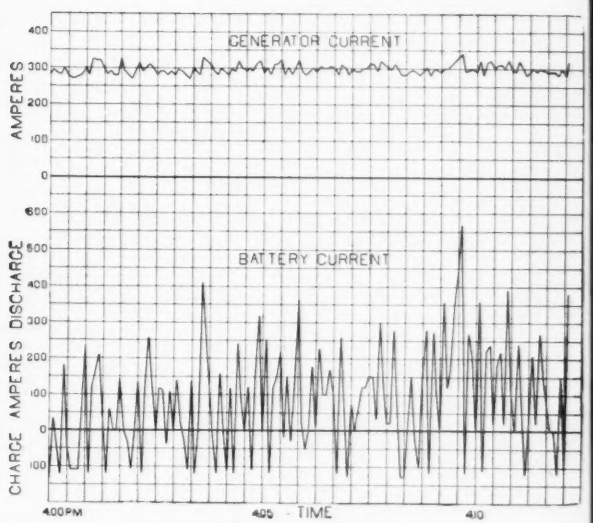
A very sensible innovation has been made by placing the battery on the roof of the building, 18 floors above the ground. It was not found that any strengthening of the roof beyond that called for in the original plans was necessary. The battery is all in one tier, and rests upon a wooden rack supported about every five feet upon brick piers. Over it a fireproof structure has been built to protect it from the weather, and the room thus formed is, of course, admirably lighted and ventilated. The battery consists of 122 cells, each having 19 plates, with a capacity of 720 ampere-hours at a one-hour discharge. Four heavy cables connect the battery with the switchboard in the basement. The greatest success has attended the operation of the plant, the lights showing no flicker due to the working of the elevators. One generator of the three is able to take care of the steady load of the plant, whereas, without the battery, two would be necessary to care for the peaks in the elevator load, while the third would have to be run on a separate system of wiring to supply the lights. The battery, which is of the familiar chloride type, was manufactured and installed by the Electric Storage Battery Company.



ACCUMULATOR INSTALLATION IN THE DUN BUILDING—GENERATING UNITS AND BOOSTER.



ACCUMULATOR INSTALLATION IN THE DUN BUILDING—MAIN SWITCHBOARD.



DUN BUILDING—LOAD DIAGRAM.

OPERATION AND MAINTENANCE OF TELEPHONE EXCHANGES.

READ BY E. B. FISHER BEFORE THE INDEPENDENT TELEPHONE CONVENTION AT CHICAGO, JUNE 27.—DISCUSSION.

The general proposition may be assumed that the greater always includes the lesser, and that a discussion of this topic from the standpoint of a larger plant will furnish the required suggestions for smaller service. Upon that theory, we will start with the idea that owners or directors of a given plant or system have selected as their representative an intermediary and officer who might be termed the general manager. He is their exponent. He has the general policy of the company; as to them, he is the organized force which is to give concrete expression to their abstract wishes. They approach him only for carrying out their plans and he is the sole authority for the general direction of their business. He must have a staff of lieutenants, if you please, who will, under his directions, see that the plans which he provided are carefully developed.

Had I the faculty and apparatus, I think I would draw a diagram illustrating this main thought, and upon the large scroll on the left side place the word general manager; on the right I would place, as his chief lieutenants, traffic manager, auditor, supply and repair department, superintendent of construction, engineering department, territorial department, and possibly, a seventh department might be named as the contract department, for to judge from some of the reports we see in the newspapers as to work our competitors are doing in Wisconsin, Michigan and other states that seems now to be a requisite. I deem it true that the first requisite in such a business is thorough organization. After that has been secured, discipline can follow and should.

In such an organization, at least as far as the public is concerned, the most important lieutenant is the traffic manager. He is the man whose immediate subordinates and their assistants come into contact with the patrons of the exchange, upon whose technical and business ability and courtesy depend in very large degree the success of the system. He must be a very good judge of human nature, competent in the selection of employés, and also when brought into contact with patrons of the exchange. As his immediate subordinates should be named the chief operator in the day system, chief operator for night duties, the switchboard inspectors and wire chief. To this list might be added, perhaps, the chief toll operator and the monitor.

The chief toll operator should be thoroughly conversant with the entire toll system reached by the exchange, the points or exchanges, of their perfection or effectiveness, and should be able to answer any query of subordinate operators upon this branch, or as to rates of service. Each one of these operators should be held to a "civil service examination" and rules for this department to the end that they may know, without apparent thought, how to reach the subscribers or points desired, which way is best, which is the second or next choice if the best way is in use, and what is the expense. This must be learned or memorized so that the answer may be immediate, and the service desired rendered at once.

One might say that the operators proper are next in consideration; as to their qualities and duties, no dissertation is necessary. We, from the managing side, and the public, from the patronage side, are in sufficient contact with them to have numerous ideas as to what they should and should not do, and we may dismiss the operators with this thought. The chief operators under the supervision of the traffic manager should be very carefully selected, and should have all the minutiae of the system thoroughly in hand.

It may just be hinted that the traffic manager and the chief operator must be thoroughly familiar with the isothermal service lines, or special stress periods of the system, when serving 1,000 or more 'phones. Without this knowledge it would be impossible to wisely regulate the number of extra operators or substitutes required, or to plan the time programme of the work, so that operators may be furnished when the public must have them, and at the same time so that these employés may secure time for rest and meals, as all humans require. A mere suggestion in this direction will carry the thought from your own observation to such further requirements as are peculiar to your own plants.

The monitors in an exchange of 2,000 'phones can earn their monthly salary almost every week in the conservation of material—in the savings of the cords alone, if you please—as well as in their other duties.

As to the auditor's department, it is not necessary to give details. The requisites as to bookkeeping, the cashier, the subordinates who take care of the directory, the rate clerks, the people who meet the public, are all performing duties which differ little from the average or ordinary employments, and good business sense will cover these particulars, as in any business.

The next department is more especially under the watchful eye of the general manager; the supply and repair department. The stock-room and the repairs of instruments and cords, etc., will be in the care of a chief who reports to and takes direct orders from the manager. Here the manager acts more directly, perhaps, than in almost any other department of the system, making a selection of material required, ordering its purchase and controlling its distribution. Thorough systems and records in this department, as to reception and disbursement of material, repair of apparatus, etc., will prove profitable in the extreme, and will increase the efficiency of the business to a degree not realized until it has been tried.

I may use next in order, though not next in proper sequence of importance, the superintendent of construction. He has charge of the external work of the plant and under him are the foremen and the various gangs of outside employés; whether they are building aerial lines or putting in conduits, or taking care of terminals, whatever their duty. This department has been more especially treated, in theory, in another paper and needs only to be alluded to in this connection. We, in the independent field, have found that the construction department has very extensive and continuous duties, hence in discussing operation and maintenance, we must allude to it if not more.

Next to the traffic manager, scarcely secondary to the general manager in importance, is the engineering department of the telephone system.

The average layman, indeed the average employé of a telephone system whether Independent or Bell, has but little conception of the intricacies and possibilities of this department.

It is my opinion that the Independents have not given this department the value it deserves, or that is necessary to their highest success and greatest profit. It is only within a comparatively short time that many of the subordinates of the Bell company have given this department of the work any consideration. It has been exceedingly useful to them and it would be vastly more useful to us, because we have not access to the experience of the entire field, as the licensees of the American Bell have had heretofore, as guides to wise action or the best methods.

The engineering department decides what methods are best, tests material for the use of the construction department or apparatus for installation, and ascertains whether such material or apparatus complies with specifications, or will perform the duties required.

Right at this point, permit a suggestion which, perhaps, is foreign to the topic and might have more direct place in the topic of construction, but, as I have hinted, I consider the engineering department of almost overshadowing importance. I believe it would be a good thing for this association to assist its membership and the independent interests generally, with the very best skill that can be commanded in this field, employing one, two or even three experts, if necessary, who shall be employed not only for testing supplies proposed, but in making specifications as to that which is requisite to accomplish the results we all know must be attained.

In the exchange with which I am more naturally familiar, our toll service has more than doubled within the past six months and is still growing at a ratio that almost overwhelms us. We think that with cheaper rates for such service than has been charged heretofore, the popularity of the telephone as a means of communication will increase beyond the wildest dreams of those familiar with this department four or five years ago. This fact is true with the Bell company as well as ourselves, and but suggests what we must prepare for. We must be wise in the establishment of rates; we must have our "clearing houses" at convenient points in our respective territories, through which rapid and efficient interchange of business may be accomplished, and we must provide for methods of operation and of maintenance on toll-lines not heretofore developed by any independent system in this country. In this field, the old company is still learning many lessons, with all of its experience. How much more important that we begin at once to give it the requisite consideration.

We know of exchanges of 100 or 200 'phones that are undoubtedly being successfully operated in their communities at very low figures of cost. It has been believed by those not well informed that larger systems ought to be, and can be, operated at similar cost. It is true in the telephone business, as it is not true in most other business, that the larger the business the greater the expense pro rata and per capita for operation and maintenance as well as for construction; where, in a plant of 1,000 'phones a rate of, say, $20 to $30 may be fairly successful, in doubling the plant, it will materially increase cost of building and compel a still greater increase per 'phone in operating.

I am of the opinion that we need, as well as the public, more information than we have yet secured in this branch, in accepting franchises or ordinances, in the larger cities of the country which are now being developed. We should not be so eager to try to secure them as to perhaps entail a serious burden upon the future of the business in the smallness of the maximum of prices permitted to be charged.

We all know that the old company has exacted an undue profit; at the same time, it would be most unfortunate if the Independents should establish a scale of rates for service that would not permit first-class service and a reasonable return upon the investment required for such service. I sincerely hope that any discussion which may follow this paper, will consider fully this part of the topic.

THE DISCUSSION.

Mr. Fair: Mr. President, I would like to ask some gentleman, who has had the experience, to tell us the proper size of plant to be run at the minimum of expense. The gentleman who has just read his paper states that a large plant can not be run at a minimum expense. For instance, we have a plant with 25 subscribers that can be run at a small expense. Now, if there is any one present who has had sufficient experience in that line, I would like to

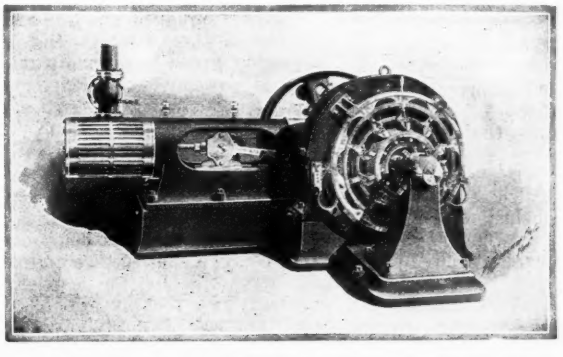
know the size of plant that can be run at the least expense per subscriber.

Mr. DeLand: Would it not be a good idea to have a committee prepare what might be called "Specifications for Franchises" to be used by the association? It seems to me that if there was a committee of that character to prepare what might be called a model franchise, we might be able to do away with the limitation clauses. In doing the work that we have been doing down in Pennsylvania and West Virginia, we have found a great many companies that have accepted franchises, as one gentleman from Ohio expressed himself a short time ago, where they were frightened into accepting such a franchise. They had to take that or get nothing. They have had clauses in their franchises limiting the rates to $12 or $15, and in one case as low as $9.

Mr. Critchfield: Of course, there are certain fixed charges, there are certain things that must be had and paid for in any exchange, whether large or small. You must have a manager and probably a collector, and there must be a lineman, and you have to provide for rent, light and heat. Now, those things cost no more ordinarily for exchanges of 200 or 300 than they do for an exchange of 100. The question almost answers itself. Whenever you get to the nearest point at which one lineman, one manager, one collector, a certain fixed number of operators that you must have in any event, you must have two for any kind of an exchange, however small it may be, one for day and one for night, and when you exceed that point, when you get to the point where, for the increased business, you must employ increased help, then you go to a point where the cost of management and operation is increased per capita. About 200 to 250 telephones ordinarily is the sized exchange that can be operated at the lowest expense per telephone. With less than that it will cost more, because you have got to have almost the same help, and if you have more than that it will cost more, the greater your investment will be, and the better your service must be, and the busier each telephone, and you require more operators. A moderately expert operator can answer 100 telephone calls an hour, and if there are 200 telephones in an exchange the average number of calls for each telephone will be small. If there are 200 or 300 or 400 or more telephones in an exchange, each patron can talk with more people and uses his telephone oftener, necessitating more operators, more drops and, consequently, very greatly increased expense in that regard.

Mr. Hogue: I want to answer the gentleman that spoke awhile ago about having a uniform franchise. I don't object to it, but I think the best way to solve that problem, perhaps, would be to start a college to educate the councilmen. You find that in every town where you attempt to get a franchise the council has different ideas, and it is almost impossible to talk those ideas out of their heads. You will find in some places that it is impossible to rent an exchange for less than $400 per year, while in other towns or cities you can get an exchange room that will answer the same purpose with perhaps light and heat for $150 per year. You will also find that your operators will cost you in some places $15 per month, while in others they will cost you $25 per month. You will also find that you can pick up 300 to 500 subscribers with a total mileage of from three to five, while in other places it will take from 8 to 15 miles to reach the same number of subscribers. In other places you will have to maintain a submarine cable to get across a river, while at other places you will have nothing of the kind to take into consideration. In some towns you will have high trees that will require 60 to 65-foot poles to get over them, while in other towns 30 to 40-foot poles will accomplish the same purpose. As you can readily see, the conditions vary so much that it is practically impossible for any one to fix a uniform rate. I do not believe it is at all possible. I think, however, there is a great tendency on the part of some, and it is usually on the part of would-be promoters, and who have not had any particular telephone experience, who go into a town and apply for a franchise, to base it on rates of $9, $10 or $12 per year. A great many people have an idea that a franchise is wonderfully valuable; that all you have got to do is to get a franchise in your pocket, and you have something that you can sell for from $10,000 to $150,000. They have heard of some one making a tremendous profit out of a franchise. My experience with franchises has been that they amount to nothing until you invest a large amount of money in developing them. When you have got the property in shape to show an earning capacity, then, perhaps, you can get an investor to look over your proposition. But you have got to take the risk to start with. You have got to demonstrate that you have thorough confidence in its capabilities by putting your own money into it. And it is hard to raise money on a telephone plant when it is in course of construction, just to start with. You have got to have backbone and nerve with it. That is practically the only way that you can succeed in developing such properties.

Mr. Fisher: I was impressed with one thought on this topic of rates, and that was this: I found in visiting various places in the middle West that a great many people seem to imagine that because a company with 250 or 300 or 400 telephones was prosperous at rates that are common in plants of that size, that it was entirely possible to operate a plant in a city like Grand Rapids or Detroit or Cleveland at the same figure. People say it is like any other business. You can do it by wholesale cheaper. I have found in trying to secure contracts for operation, and in the case of persons trying to secure franchises, that city councils have met them with that general idea; and in some cases those who would invest in the telephone business have been careless, and have accepted rates that were almost certainly destructive of their investment. Now, I simply wanted in this connection to sound a note of warning, and have each one of you say to your neighbors and friends that they must be careful in that direction, that they must not get the impression because they are operating plants in towns of 5,000 or 6,000 successfully, at a given rate, that they can come to a town of 40,000 or 50,000 and operate at a greater profit because of the larger number of possible patrons. There is too much vagueness and lack of information in that direction. My experience in Ohio and in Michigan on these questions has led me to say what I have this afternoon. By the way, in that same connection comes this thought: You who are interested in the smaller plants and desire service in larger cities could help your neighbors and friends in the larger cities by making that fact clear to them. You will frequently be called upon by officials and others connected with the larger cities for statements as to what rates you are getting and perhaps what profits you are making, and because they are not fully informed upon that very branch of the subject they go home with the idea that they must establish certain limitations for the benefit of their people in the franchises they grant, or no franchises will be granted. Now, we have to live and let live in this field, and we must not get our rates so low as to prevent our giving just as good service as anybody in the world can give.



RIDGEWAY DIRECT-COUPLED ENGINE AND GENERATOR.

Increase in Use of Direct-Coupled Engines and Dynamos.

The engines with direct-coupled generators, manufactured by the Ridgeway Dynamo and Engine Company, of Ridgeway, Pa., have created a large demand for this type of engine among plants where a considerable amount of power is necessary, and only a limited area of space can be used.

The Ridgeway engine, with direct-coupled generator, takes up hardly one-half the room of the ordinary type and is more compact and even in its adjustment. The accompanying illustration shows the standard type of their generators, direct-coupled with their engine. Many of the large power plants and mills throughout the country have recently adopted their make.

They report the following orders lately received:

Two 250-horse-power engines, direct-coupled to two 150-kilowatt generators, from the Lukens Iron and Steel Company, of Coatsville, Pa., and two 250-horse-power engines, direct-coupled to two 150-kilowatt generators, and a 200-horse-power engine, direct-coupled to a 125-kilowatt generator, from the Pressed Steel Car Company, of Pittsburgh, Pa.

Wall Street and the Electrical Stock Market.

Although the current business week was a brief one, the average of prices was fairly maintained. On the whole the weather has been favorable to the growth of crops, although there are several months of uncertainty ahead. The country's trade is almost unparalleled and the outlook continues to be most flattering. On the New York Stock Exchange General Electric closed the week at 118⅛ bid and 118½ asked. Metropolitan Street Railway, of New York, closed at 224 bid and 225 asked. Third Avenue Railroad, of New York, closed at 182 bid and 190 asked.

On the Boston exchange American Bell Telephone closed at 340 bid and 348 asked. Erie Telephone closed at 96 bid and 96½ asked.

On the Philadelphia exchange Electric Storage Battery common closed at 134 bid and 135 asked. Union Traction closed at 42⅛ bid and 42⅜ asked.

On the curb or outside market in New York, Electric Vehicle closed at 107 bid and 111 asked. Electric Boat closed at 17 bid and 20 asked.

Wall Street, July 8.

MUNICIPAL OWNERSHIP AT DETROIT.

AN EXPERIMENT IN PRACTICAL SOCIALISM AND ITS ECONOMICAL RESULTS.

In recent issues of the *Economist*, Mr. Samuel Insull, president of the Chicago Edison Company, and past-president of the National Electric Light Association, analyzes at length the operations of the municipal lighting plant at Detroit, and very conclusively shows the futility of such an installation.

In beginning his analysis Mr. Insull says: "It is the most modern, best built, best equipped, best managed and has the best accounting system of any public lighting plant in the United States.

"Its construction was commenced in 1893. It began operation April 1, 1895, with 189 arc lamps. Its reported cost for the year ending June 30, 1898, was $790,145.73. Its history furnishes a marked example of what is accomplished by the people when they take possession of a public service industry, in their governmental capacity, to secure all advantages for their own benefit. In the examination of this history which follows, every statement is based upon the accounts of the public lighting commission of the city of Detroit. The figures given in the official reports are accepted as correct, excepting in cases of omissions or underestimates. No attempt whatever is made to analyze the accounts for operating expenses. All charges under this heading are used as given in the reports, and without criticism.

"This plant does no commercial lighting. It is used only for lighting streets and public places and to operate incandescent lamps in public buildings. Its service being entirely for the public, its ownership and operation present no problems for adjustment to balance the interests of private users with those of public users—taxpayers. It is exclusively a taxpayers' plant. Its construction was advocated for the benefit of taxpayers. It is operated for the account of taxpayers. All advantages or disadvantages derivable from it belong to taxpayers. These facts render an examination of its history, and of the economic results of its ownership and operation, a matter of special interest and moment to every municipal taxpayer in the United States."

He then lays down the fundamental principles that taxpayers are property owners; and that it is the function of the law to protect the rights of ownership. Arguing from these he shows the initial error, due to the duplication of plants in Detroit—a good private plant already existing when the municipal station was proposed. He gives the history of the municipal undertaking, which appears to have been due to purely political considerations, and analyzes at length the reported figures of cost. The conclusion drawn from this study of the costs is of deep interest to electric light investors and to every municipal taxpayer. The table below gives the results during the first year's operation:

REPORTED AND TRUE COSTS TO TAXPAYERS PER LAMP PER YEAR. FIRST REPORT, 1896.

Items of cost.	Reported costs.	True costs.
Arc lamps in service, average for year, 1,483.		
Total investment June 30, 1896, $630,141.72.		
Fixed charges:		
Interest, report 1896	$16 18	$16 18
Insurance	none	none
Taxes, municipal and state, relinquished	none	4 80
Depreciation*	none	*21 24
Total fixed charges	$16 18	$42 22
Operating expenses, report 1896	68 52	68 52
Taxes invested, report 1896	none	22 03
Provision for payment of bonds	none	8 09
Total reported and true costs.	$84 70	$140 86
Price offered on a 10 years' contract, February 7, 1893, report 1896.	102 20	102 20
Apparent saving and true loss to taxpayers	17 50	38 66

Taxpayers' loss on 1,483 lamps, $38.66 per lamp, $57,332.78.

*Depreciation in "true costs" is calculated at five per cent on total investment.

After this summary, which turns the searchlight of common sense squarely upon the conditions surrounding the plant, Mr. Insull analyzes the second and third annual reports, and from his examination draws 12 conclusions, which he aptly calls "Lessons Taught by Experience." They may be briefly summarized thus:

I. Easy to Promise, Hard to Do—The difference between promises and performance may be traced by comparing the statements made about the dates when the plant was to be completed and in operation.

Mayor Pingree: "It will undoubtedly be in operation before July 1 (1894)."

First Report, June 30, 1897: "The close of the fiscal year, June 30, 1897, saw practically the completion of the 2,000-arc-lighting plant of the city of Detroit."

Third Report, June 30, 1898: "The plant has been in existence since April, 1895, but it is only since November 1, 1897, that the construction feature of our business was completed and the plant placed upon a purely operating basis."

II. Cost of Plant—First Report, June 30, 1896: "On May 9, 1893, the Common Council authorized the issue of bonds to the amount of $600,000 to defray the cost of erecting the plant."

First Report, June 30, 1896: "Net cost of plant to date, $630,141.72."

Second Report, June 30, 1897: "The investment of the city of Detroit in its lighting plant now amounts to the sum of $729,222.73."

Third Report, June 30, 1898: "Total investment $790,145.73."

III. Saving to the City—It is clearly proved by this analysis of the official reports that all apparent "savings for the city" are shown by underestimating some of the factors of cost and the entire omission of others. If any lesson is needed to teach taxpayers the absolute necessity, for their protection, of a uniform system of municipal accounting prescribed and audited by the state, designed to show the entire and true cost of all services rendered by municipally owned and operated industries, this examination of the accounts of the Detroit municipal electric lighting plant should be sufficient to supply that want. The heroic effort to cut the price in two, even by this method of incorrect bookkeeping, was a dismal failure.

IV. Interest—Second Report, June 30, 1897: "Interest was figured (in the first report) only on the bonded indebtedness, which was much short of the actual investment." This is a direct acknowledgment of the principle that *interest on the entire investment* is a part of cost.

V. Taxes Relinquished — Second Report, June 30, 1897: "Last year (1896) there was no attempt to figure loss of taxes."

Third Report, June 30, 1898: "To arrive at the cost of an arc lamp there should be added a certain amount for loss of taxes through the plant not being owned by private parties."

This is an acknowledgment of the principle that loss of taxes, through removing property from private to municipal ownership, is a direct loss to taxpayers.

VI. Depreciation—The commission can make a compromise with opinions but it can make no compromise with facts. What the commission considers will have no more effect upon the results of experience than the allowance of nothing per lamp for depreciation in 1896, and of $1.85 per lamp in 1897, had on the $11.51 per lamp it allowed in 1898. The only result of an inadequate allowance for depreciation is to enable the present to rob the future. It is great fun to brag about the enormous saving to the city where no depreciation is charged, but it is painful to account for the inability to make a profit when depreciation takes effect.

VII. Taxes Invested — In none of the reports is there any recognition of the fact that the taxpayers' money invested in the plant is as much a part of the cost to him of the service as the money raised by taxation to pay for labor and material. It is a simple proposition that a thing costs what one has to pay for it.

VIII. Provision for Bond Payment—It is strange to find in the accounts of a plant built by an issue of $650,000 in bonds that no reference to any provision for the payment of the bonds is made. It is as certain as any rule in arithmetic that one-thirtieth of the life of a 30-year bond is exhausted with each passing year of operation, and that pay-day will come. Proper provision for the payment of the bonds at maturity is a part of the annual cost to taxpayers of a municipally owned and operated lighting plant.

IX. The Relief of Taxpayers—Taxpayers have been relieved by following the advice of their political friends, in excess of what a private corporation asked from them, of the following sums of money:

1896. Taxpayers' loss ... $57,332 78
1897. Taxpayers' loss ... 60,057 60
1898. Taxpayers' loss ... 51,429 76

Total loss for three years. $168,820 14

In addition to this they have a mortgage on their property for $650,000—less the provision for bond payment included in the above statement of loss.

X. Contract Price Fixes Cost—When light is furnished from a municipal plant its cost to the taxpayer is every cent taken out of his pocket on its account, no matter how expended. Of all the dollars taken out of a taxpayer's pocket by taxation *not one dollar ever returns.*

XI. An Attack on Private Property — The demonstrations given should cause taxpayers to see, when politicians attack corporations with the cry of municipal ownership as a means of securing for the people all of the advantages licked up by corporate greed, that the real attack is not upon corporations, but upon themselves. Every dollar taken from a taxpayer by taxation to be invested in, or to operate, a public service industry is confiscated. It never returns to him.

XII. The Workingman — In its struggle to keep down costs so it could show even an apparent gain the public lighting commission of Detroit pinched its saving out of its employés as heartlessly as ever did a private employer. They had to do it and they did it. They evaded the eight-hour law by placing employés on salary and then allowing them nothing for overtime. They took $10.30 per lamp of the savings afforded in 1898 out of labor and only $2.04 out of material.

Automobiles in Parks.

Judge Gibbons, of the Superior Court, Chicago, has decided that the ordinance passed by the South Park Commissioners prohibiting the use of electromobile vehicles in boulevards and in parks is void, and that the commissioners have no authority to pass such an ordinance. The court discharged Harry G. Osborne, of the American Electric Vehicle Company, who was arrested under the ordinance several weeks ago and who applied to Judge Gibbons for release on a habeas corpus writ.

The ordinance which Judge Gibbons condemns was in force for only a few days. After Mr. Osborne and the company he represents took the matter into Judge Gibbons's court, the Park Commissioners refrained from enforcing the order against electromobiles until a decision could be announced. The law gives the Park Commissioners no right to appeal and the electromobile men were satisfied with the decision, so the deliverance of Judge Gibbons was accepted as settling the matter finally.

ELECTRIC LIGHT FLASHES.

The city electric light plant at Mentone, Ind., has been purchased by Alexander Lindsey, of this city.

The Boston Electric Light Company has declared a quarterly dividend of $1.50 per share, payable July 15 to stock of record June 30.

The Stoughton, Mass., Gas and Electric Company are preparing to introduce a plant for the purpose of supplying electricity for incandescent lighting in town.

The newly incorporated Denver Gas and Electric Company, which has combined the lighting plants of Denver, Colo., will lower the price of gas and electricity. Mr. Emerson MacMillin has been chosen chairman of the board of directors.

The plant of the Tunkhannock, Pa., Electric Light, Heat and Power Company, with all the rights and franchises, has been sold under the Sheriff's hammer for the sum of $8,000. The purchasers were Henry M. Ives, of Scranton, and John B. Russell, of Wilkesbarre.

M. H. Forbis and W. B. and E C. Cooley, owners of the Hartford City, Ct., Light and Power Company, have sold their plant to M. H. Herbert, of Cambridge City, and B. Ellison, of Lagrange. The consideration is not made public, but is believed to be near $25,000.

A New York syndicate, with which are said to be connected S. R. Bertrom and I. S. Storrs, has just completed a deal whereby it assumes ownership of the gas and electric light and power plant of Glens Falls, N. Y. The purchase price has not been made public. It is stated that $50,000 will be expended on improvements, and work has already been begun.

At the annual meeting of the Economy Light, Heat and Power Company, of Scranton, Pa., the following officers were elected: President, L. A. Watres; vice-president, Robert Reeves; treasurer, John T. Porter; secretary and manager, W. J. Northup. Directors: E. N. Willard, W. F. Hallstead, L. A. Watres, Robert Reeves, C. D. Jones, John T. Porter, A. B. Stevens, P. J. Horan, W. J. Northup.

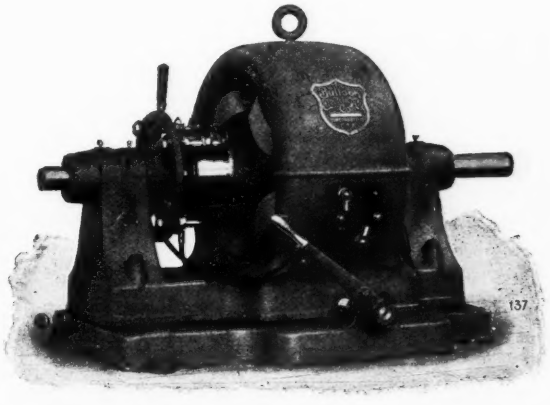
The electric power plant of Gopher Boulder Mining Company at the junction of Rock Creek and the American River, eight miles from Placerville, Colo., has been destroyed by fire. The plant was one o. 110 horse-power and was used for the transmission of power for the operation of the Gopher and the Boulder quartz mines near Kelsey. It was installed about 12 years ago and was the first plant erected for the transmission of electricity for a long distance in the state. Loss about $15,000; no insurance.

The Pine River Light and Power Company, of Tustin, Mich., has been incorporated, with a capital stock of $60,000, all of which is taken. The object is to erect a plant on the Pine River, five miles west of Tustin, and run lines from there to Cadillac, a distance of 17 miles, with a view to furnishing that city with electricity at a low rate for lighting, heating or factory purposes. J. H. Andrews, of Reed City, is the promoter of the organization. Work on the dam will be begun at once, and it is expected the plant will be in operation by September 1 next.

It has been reported in Hoboken, N. J., that the North River Light, Heat and Power Company, which was organized about six months ago, with a capital stock of $300,000, had been absorbed by the shareholders of the Hudson County Gas Light Company, of that city. Although the stockholders of the former company admitted that they had sold their interests, receiving all they had paid and 10 per cent in addition, no definite information as to the purchasers could be ascertained. The purchase was made by Myles Tierney, one of the largest shareholders in the Hudson County Gas Light Company, which gives rise to the rumor that the gas company is interested in the deal. President S. Bayard Dod, of the gas company, denied that his company was the purchaser. Mr. Tierney declined to disclose the particulars of the sale.

Slow and Moderate Speed Motors.

The gradual evolution in electric motor design has led to the perfection of types of these machines, which combine the highest electrical efficiency with the greatest possible simplicity and mechanical strength. There is to-day no machine of any sort which is more admirably fitted to perform its duties than the highly developed electric motor. The illustration shown herewith represents a type of motor, adapted to be belted to its load, which combines in a high degree the various electrical and mechanical perfections that have lately been attained in the construction of such machines. The armature is deeply slotted and wound with machine-made coils, thus securing electrical and mechanical balance.



BULLOCK BELTED MOTOR.

The ancient device of banding wire is dispensed with, and the coils are held in place in the slots by retaining wedges of hard wood running the length of the core and engaging in slots in the tops of the armature teeth. As in other machines of careful design the entire armature insulation is of mica. The large commutator is made of hard drop-forged copper and insulated throughout with mica in the usual way. The brush-holders, being of the reaction type, necessarily make perfect contact with the commutator and bear upon it with an even pressure. The pole-pieces are laminated and are cast into the steel magnet frame. As may be seen from the illustration, there is a free circulation of air through the working parts of the machine which can stand, consequently, a temporary overload of 35 per cent, and can run a half-hour at a 25 per cent overload without dangerous heating. The bearings are long and large and are supplied with reliable self-oiling devices. The motor is manufactured by the Bullock Electric Manufacturing Company, Cincinnati, and the design shown is made in 13 sizes, ranging from 7 to 375 horse-power.

A Large Street-Railway Combination.

The United Power and Transportation Company was organized recently, and consists of John A. Rigg, of Reading; R. C. Carson, of Philadelphia; E. J. Moore, of Philadelphia, and one or two other well known railroad men. Its capital, authorized under a New Jersey charter, is $12,500,000. It has purchased several important roads, purchasing them outright and giving for them trust certificates bearing four per cent. The roads in question are the Reading, Pa., system of railroads, the Lebanon, Pa., system, the Wilmington, Del., City Railway Company, the Wilmington City electric light plant, the Chester, Pa., Traction Company, the Roxsborough, Chestnut Hill & Norristown Road, the Frankford, Tacony & Holmesburg Road, the Delaware County & Philadelphia Electric Railway and the Clifton Heights Electric Lighting Company. Also included in the purchase are the electric railroads of Trenton, N. J., and the Wilkesbarre & Wyoming Valley Traction Company. This comprises all of the present purchases. It is said by those who know that last month's increase over the previous month, or since the United Power and Transportation Company took hold of the different roads, has been as much as $30,000. Increases are confidently expected, as those connected with the system are thorough railroad men, and are said to have gone into this matter as an investment. The stock has advanced, since it was placed on the market, from 20 to 29.5; and there is very little stock offering even at this considerable advance. The par value of the stock is $25, with $10 in cash paid in and no order. The largest purchase was the Wilkesbarre & Wyoming Valley Traction Company, for which $41 per share in cash was given for the entire capital stock.

At a meeting of the Southern Electric Light and Power Company, of Philadelphia, Pa., the following officers were elected: President, William F. Harrity; vice-president, John M. Mack; secretary, Ellis Ames Ballard; treasurer, Winthrop Smith. The board of directors consists of the following: John M. Mack, William F. Harrity, Thomas M. Thompson, Clarence Wolf, Isaac A. Sweigard, Dr. John V. Shoemaker and Winthrop Smith. William J. Manning is continued as general manager of the company.

THE PROTECTION OF SECONDARY CIRCUITS FROM FIRE RISKS.*

BY DR. CARY T. HUTCHINSON.

The best protection of secondary circuits from the dangerous consequences of an abnormal potential in these circuits has long been the subject of discussion. In the early days, when the house-to-house transformer system was general, many fires were caused by the failure of the insulation between the primary and secondary coils of transformers; this was then the chief cause of such accidents. No secondary distributing networks were then used, and, consequently, fires following a failure of insulation were confined to the circuits from the single transformer. It was unusual for a wide-spread fire to occur, and public attention was not as strongly directed to the matter as it has been of late.

In the last few years the use of alternating-current systems has increased greatly; individual transformer systems have been replaced in many places by the use of "banked" or "grouped" transformers, with secondaries feeding a low-pressure distributing network. Such systems are now in operation in many places in the country, and their number is increasing. The secondary distributing networks may be of two, three or more wires, the latter for two or three-phase systems. The secondary circuits in all such systems are directly liable to the incursion of the high primary pressure through the failure of the insulation at some point.

In addition to alternating-current systems, there is another class of distributing systems subject to the same dangers—systems in which transformation is made from high to low-pressure alternating current, and thence, by means of synchronous converters, to low-pressure direct current for distribution. The use of such systems is growing rapidly; many of the Edison illuminating companies are already employing them, and it is a safe prediction that all the large companies will be obliged to adopt methods of this character in the near future.

Such a system has precisely the same conditions of insulation between the low-pressure direct-current distributing mains and the high-pressure alternating-current feeders as a plain alternating-current system, since the low-pressure side of the alternating-current supply is connected metallically to the armature of the synchronous converter which feeds the low-pressure direct-current distributing system. In a word, there is only one insulation between high-pressure alternating-current feeders and the low-pressure direct-current network; hence such a system is liable to precisely the same risks as is the straight alternating-current system.

*Paper read before the Boston meeting of the American Institute of Electrical Engineers, June 27, 1890.

There are a number of ways in which the high-pressure alternating potential can get to the secondary system. The most obvious is the failure of the insulation between the primary and secondary coils of the transformer; another is the contact of the high-pressure feeder and the low-pressure distributing main which may run on the same pole line, or in the same conduits under ground. Wires that in ordinary circumstances seem to be secured beyond the possibility of contact may be brought into contact through unusual conditions, as in a heavy storm, or by foreign wires falling across them.

The effect of the failure of insulation, however caused, depends upon the condition of the secondary system. A brief statement of the various possible consequences may help to make the matter clear.

Any circuit, overhead or under ground, carrying alternating currents, is a condenser, of which the capacity depends upon the point of view. In an overhead circuit, there is a certain capacity between the two wires, considered perfectly insulated, each as the plate of a condenser; there is also the capacity of each of these wires referred to earth, each wire being regarded as one plate of a condenser, and the earth as the other plate. The capacity in the first case fixes the difference of potential between the two wires for a given charge, or, conversely, for a given difference of potential between the wires fixes the charge. The capacity in the second case, that is, regarding the earth as one plate of the condenser, fixes the potential of the wire above or below that of the earth for a given charge, or conversely. The capacity in these two cases need not have the same numerical value.

The same general considerations hold in the case of underground conductors; there is the capacity between wires determining the difference of potential between the wires, and the capacity of each wire and earth, determining the difference of potential between that wire and earth. The difference of potential between wires of a circuit transmitting energy is fixed, and the capacity is determined by the dimensions of the circuit; hence the charging current is fixed. This charging current is the current on the system when no energy is transmitted and there is no leakage.

Calling V_1 and V_2 the potentials above and below the earth respectively of the two wires, and C_1 and C_2 their capacities, the equation

$$\frac{V_1}{V_2} = \frac{C_2}{C_1}$$

will hold in all cases. If one wire is connected to ground, that is, if capacity C_1 becomes infinite, the potential V_1 becomes zero. Under ordinary circumstances, the capacities of the two wires are substantially the same, and the potentials, so far as determined by the capacities, are equal and of opposite sign with respect to the earth.

Leakage over the insulators to earth has a similar effect, tending to fix a relation between the potentials of the two wires and the earth; that is, it tends to maintain the potential of the two wires at a certain value above or below the earth, but in no way affecting the difference of potential between the two wires.

Calling the conductance of the two leakage paths to ground G_1 and G_2, the equation

$$\frac{V_1}{V_2} = \frac{G_2}{G_1}$$

holds, and if G_1 is made infinite, or one side is grounded, the potential of that side becomes equal to the potential of earth. If the conductance of the leakage paths on the two sides of the circuit is the same, the potentials tend to become equal and opposite with respect to the earth.

The resultant effect of leakage currents and of the static capacity of the overhead system tends to cause the potential of the two wires to become more or less approximately equal and of opposite sign with respect to the earth when the circuits are symmetrical and insulated. In a circuit having a difference of potential of 2,000 volts, the difference of potential between either wire and the earth is 1,000.

The primary circuit then forms a condenser; any insulated conducting body in contact with either of the primary conductors becomes a part of that conductor, and therefore part of one plate of the condenser, and at once acquires the potential of the wire with which it is in contact; that is, if an insulated secondary system is by any means brought in contact with an insulated primary system in which the potential difference is 2,000 volts, this secondary system at once acquires a potential of 1,000 volts above the earth. If the secondary system in addition has an electro-motive force acting in its own circuit, then the difference of potential between this secondary circuit and the ground is increased or diminished by the voltage of its own circuit; in the extreme case, a difference of potential of 1,000 volts plus the voltage of the secondary circuit (say 100 volts) would exist, or, in all, 1,100 volts between one side of the secondary circuit and ground; between the other side and ground the difference of potential would be 1,000 volts. It is important to note that this difference of potential exists when the primary circuit is insulated. While this is true, it is also true that no current other than the charging and leakage current of the system can pass through the secondary system unless the primary system is grounded on the side opposite to that making contact with the secondary system. The charging current of the condenser will be practically inappreciable in all cases. For instance, at a frequency of 60 cycles per second, with a primary pressure of 2,000 volts, the charging current is only three-fourths of an ampere for each microfarad capacity of the primary system. As the capacity of the primary system will probably be a fraction of a microfarad, it is clear that the passage of this current through the secondary system can not possibly be the direct cause of danger.

The danger then lies, not in the application of an abnormal pressure to a well insulated secondary system, but in such application to a secondary system where the insulation is too weak to stand the stress brought upon it. In ordinary house-wiring systems designed for, say, 110 volts, the application of 1,000 volts may or may not break down the insulation from ground, depending upon the care with which the work was done and the goodness of the materials used. If the insulation of the secondary system from ground breaks at only one point, and if the break is of such a character as to dead ground the secondary, then the abnormal pressure is at once relieved: the maximum potential above the earth that can exist on the secondary system as soon as this ground is formed is the voltage of the secondary system; the moment the ground is formed, the danger is removed; abnormal current can not flow and consequently no fire can begin.

Assume, however, that the insulation of the secondary system is broken down at two or more points on opposite sides. In this case a short-circuit is formed of resistance varying between zero and some higher value. The electro-motive force acting in the secondary circuit, either alternating or direct, sends current around this short circuit, in amount depending upon the resistance of the short-circuit. The current continues to flow until the grounds are entirely removed, or until the circuit is isolated, by fire or otherwise, from the source of supply. This abnormal current flowing around the short-circuit causes the fires; at every point where the current flows to ground, more or less energy is liberated in the form of heat, and fires will occur if local circumstances are favorable. The application of an abnormal pressure to the secondary system, in all probability will break down the insulation of the secondary system at several places, and these places will be distributed between two sides of the secondary system, as a matter of probability.

If the primary circuit is grounded on one side, and contact is made between the grounded side and the secondary, no harmful consequences can follow. If contact, however, is made between the insulated side and the secondary system, the full difference of potential of the primary will exist between the secondary and the ground—that is, twice the difference of potential that existed in the case of the insulated primary. To all intents and purposes, the difference in effects caused by grounding one side of the primary circuit will not be material. One-half of the difference of potential of the primary circuit will probably be as effective as the whole.

Although alternating-current elec-

tric lighting systems have been in use in this country for a number of years, no definite practice has been followed for the protection of secondary circuits. The chief improvements that have been made in the art have been in the character of the insulation between the primary and secondary coils of the transformer. After careful investigation as to the present practice here, I am in a position to say that in practically no case is any device regularly used to protect secondary circuits against abnormal pressure. A number of station managers have attempted to use, and in a few cases have used, devices such as I am about to describe, for a short time. The outcome of all such work has been, in general, unsatisfactory. The need of some effective method for protecting secondary circuits is well recognized, yet there is at present probably no device for the purpose that is thoroughly trustworthy and efficient in all circumstances.

The means that have been employed for this object may be classified generally under three heads:

1. Devices intended to ground, short-circuit or open-circuit, the secondary circuit when subjected to an abnormal difference of potential.

2. Grounded metallic shields interposed between the primary and secondary coils of the transformer.

3. Permanent grounding of the secondary system.

Under the first class are the Cardew earthing device, in which a flexible metal strip is attracted to a fixed ground plate by the action of the abnormal potential, thus grounding one or both sides of the system; the Thomson film cutout, in which an insulating film designed to withstand the working pressure, but to puncture at an abnormal pressure, is connected on one or both sides of the circuit between two plates, one connected to the conductor, the other to earth; the Stanley automatic circuit-breaker, in which a flexible metal plate is attracted by the abnormal pressure to a fixed plate, thereby closing a local circuit through a solenoid, which acts to open the main switch on the secondary circuit; and others of similar character.

These devices all have one fundamental weakness—they do not prevent the existence of the abnormal potential, but merely aim to remove it quickly; they all require time to act—the secondary system acquires the abnormal potential at all points at the same instant, and there is no certainty that the insulation of the circuit, say at a combination fixture, may not give way before the device acts. Further, those that act to ground and to short-circuit the secondary depend upon the blowing of fuses before the cause of danger is removed; those that disconnect are subject to all the criticisms brought against high-voltage, quick-acting switches—in particular, the maintenance of the arc.

I believe that all devices under this class are, at best, temporary makeshifts.

The grounded shield is obnoxious to various criticisms—it is not effectual with a cross outside of the transformer, and therefore is of no value in many cases; it must be heavy enough to dissipate the energy of the short-circuited primary quickly; otherwise it melts and is itself the cause of a fire; it degrades the transformer, tending to cause unsatisfactory service, particularly in the regulation.

The third method, grounding the secondary permanently, is the only sure way to prevent the potential above earth of the secondary system rising above the voltage of the circuit. With a system grounded on one side, the maximum difference of potential that can exist between any point of this system and earth under any circumstances is the voltage of that circuit. No cross nor any failure of insulation of the primary or secondary circuits can raise the difference of potential between the secondary circuit and ground above this. That side of a primary circuit touching a grounded secondary circuit at once acquires the potential of the ground or a potential differing from that of the ground by the voltage of the secondary circuit. The grounding of the secondary circuit thus absolutely insures the safety of the circuit as regards abnormal pressures; it makes permanent the condition that the various protective devices seek to establish—devices that may or may not work, depending on many conditions.

It would seem that a remedy as simple as this—one generally applicable—would have been applied in all cases; but the fact is that it has attained a limited use only. The reason for this state of affairs is the refusal of the Board of Fire Underwriters to authorize the practice of grounding any part of a circuit carrying current. The underwriters take the position that to ground one side of a circuit brings about an increased liability to fire, because the full voltage of the circuit continually acts upon the insulation of the circuit, instead of one-half of this voltage, as in an insulated system, and because one accidental ground on the insulated side may cause a fire. The danger with grounded circuit is said to be increased by the fact that the full voltage of the circuit, instead of one-half, acts upon the insulation of the insulated side. This argument implies two things: first, that insulation good enough to withstand half the voltage of the circuit is not good enough to withstand the full voltage of the circuit; or, that danger would be materially increased by having the full voltage of the circuit on the insulation, instead of one-half. This is contradicted by the fact that the underwriters' rules class all circuits having a difference of potential of 300 volts or less as low potential, to which the same rule applies. That is, in the case of an insulated 110 volt circuit, which means 55 volts on the insulation of each side, the same rules hold as in the case of 220-volt circuits, with 110 volts on the insulation of each side.

If the 110-volt circuit had one side grounded, there would then be 110 volts on the insulation of the ungrounded side. It is true that the classification ostensibly permits only 150 volts on the insulation of one side of the circuit; hence, if one side of a 220-volt circuit is grounded, the stress brought upon the insulation is greater than is seemingly permitted, but, as a matter of fact, the factor of safety in work of this kind is much greater than called for by this slight difference. There is no doubt that a wiring system, properly installed in accordance with the rules laid down by the underwriters, is perfectly safe with 300 volts on the insulation on one side, and, practically speaking, it is just as safe with 300 as with 150 volts; if the former would cause trouble so would the latter. I have assumed that one conductor of a two-wire system is grounded. If the middle point of the secondary coil of transformer be grounded instead of one wire, then the stress on the insulation is in all cases one-half of the voltage of the circuit, precisely as in the case of the grounding of the neutral of a three-wire system, mentioned below.

The main objection brought against grounding is, however, not the increased stress brought to bear upon the insulation, but the fact that only one additional ground is required to establish conditions favoring a fire. The argument is, that the simultaneous existence of two grounds on the opposite sides of the circuit is less probable than the occurrence of a single ground on the insulated side of a grounded circuit.

I do not consider these arguments strong for several reasons. In the first place, they imply that an indefinite condition as regards the insulation of the circuit is preferable to a clean-cut, definite condition. Circuits supposably insulated may or may not really be so, and as a matter of fact the full stress may be, and frequently is, on one side of the circuit; the very condition that the underwriters refuse to sanction is continually occurring without such sanction.

The Association of Edison Illuminating Companies has had a Committee on Grounding the Neutral since 1890. The recommendations of this committee being based on extensive experience, are entitled to great weight. Their recommendations have uniformly been that the greatest safety was assured by the practice of grounding the neutral. This is the practice of nearly all the large Edison companies, as is well known. In some cases the companies have been forced to this position because they were not able to free the neutral from grounds; in other cases they have deliberately adopted this as the best remedy for many troubles due to operation, to dangers from fire, and to abnormal pressures.

This committee has claimed at all times that grounding the neutral has the advantage of "Reduced fire risk, since a ground created inside a building will, if on the neutral conductor, be in no danger, while if on the outside conductor it will probably fuse a safety catch, or do all the damage of which it is capable at once, and not remain inactive until the appearance of a subsequent ground on the opposite side of the system, at a time, perhaps, when no person may be at hand.

"Also, that the electrical pressure capable of causing damage by reason of any ground established, either in tubes or in buildings, is limited to 120 volts, whereas the active pressure might otherwise be 240 volts; and for overhead circuits greater immunity from lightning."

The disadvantages reported by this committee are possible troubles in operation, particularly in regulation and excessive registration on the meters, but no increased risks are foreseen. The committee has made its reports in face of the fact that the underwriters have uniformly refused to countenance the practice.

It is a notorious fact that the systems in nearly all of the large cities, particularly the Edison systems, are grounded, the neutrals in most cases being permanently grounded at the junction boxes. It is equally well known that in several of the large alternating-current distributing systems the neutral wires are grounded. The authorities of the Board of Underwriters certainly should, and probably do, know these facts. To keep rules in print prohibiting such practice under the circumstances must weaken their authority and lessen the respect for all their rules.

The rule against grounding the circuit is not the only one that is continually violated, and, by inference, with the knowledge of the Board of Underwriters. The second is that which calls for double insulation between primary circuits carrying 6,000 volts or more, and secondary house-wiring systems. I protested against this rule when it was promulgated, citing cases where it was violated at that time, and saying that it would without doubt continue to be violated. It is violated in every large city employing alternating-current distribution with synchronous converters feeding a direct-current distributing system, as, for instance, in Brooklyn, New York and Boston, not to go further. Such a rule is vicious in its tendencies, and should unquestionably be modified.

In this discussion, alternating and direct-current systems are considered subject to the same risks; this is the case now in the large cities where synchronous converters are used, but, in any event, the arguments outlined will apply to any system subject to an abnormal potential, whatever may be the cause.

This is a matter that concerns every electrical manufacturing company and engineer in the country; this Institute has recently taken part in the formation and modification of rules governing electric installations and has indorsed the national electrical code. Therefore, it is entirely in the province of this body to make recommendations as forcibly as it may see fit to the Board of Underwriters.

ADVANCE INFORMATION

New Telephone and Telegraph Companies.

NEW HOLLAND, PA.—The York Telephone Company is extending its lines to this place.

SYRACUSE, N. Y.—The Syracuse Telephone Company has been incorporated. Its capital stock is $450,000, and it is to connect with all points in Onondaga County, and especially points in the city of Syracuse. The directors are J. J. Jermyn, John L. Wentz and Frank H. Jermyn, of Scranton, Pa.; George C. Wentz, of Drifton, Pa., and Edward Barneman, Ernest L. White, Manning C. Palmer, Arthur R. Peck and H. W. Plume, of Syracuse.

WORCESTER, MASS. — The Worcester Telephone Company has been incorporated to operate telephone and telegraph companies; capital, $200,000; incorporators, H. F. Harris, W. P. Searles, H. S. Pratt.

COLUMBUS, OHIO — The American District Telegraph Company has been incorporated, with a capital stock of $10,000. The incorporators are I. N. Miller, C. E. Page, A. B. Clark, R. E. Miller and Louis O. Ireton. All of these gentlemen are from Cincinnati and prominently connected with the Western Union Telegraph Company.

JOPLIN, MO.—A new long-distance telephone service between this place and Kansas City is to be inaugurated soon. The new line will run from Joplin through Galena, Weir City, Fort Scott and other towns to Kansas City.

HAMILTON, OHIO—The American District Telegraph Company has been incorporated; capital, $10,000; incorporators, I. H. Miller, A. B. Clark, R. E. Miller, L. A. Iveton, C. E. Page, all of Hamilton.

BLOUNTSVILLE, TENN.—The Holston Telephone Company has been incorporated; capital, $1,000; incorporators, J. C. Henry, J. B. Wolf, W. E. Wolf, E. J. Burkey, W. C. Webb, all of Blountsville.

LANSFORD, PA.—The Carbon Telephone Company has been incorporated; capital, $2,000; incorporators, W. D. Zehner, E. H. Kistler, A. J. Thomas, J. A. Quinn, D. A. L. Davis, all of Lansford, and others.

TUCKERTON, N. J.—The Tuckerton & New Gretna Telephone Company has been incorporated, and will run a line from this place to New Gretna.

LEXINGTON, KY.—The City Council has granted a franchise to the Fayette Telephone Company, which will at once begin putting up lines in city and county in opposition to the East Tennessee Company, which was supposed to have the exclusive franchise in this city.

SCRANTON, PA.—The Pocono Mountain Telephone Company has been organized and will extend its lines between Mt. Pocono and Stroudsburg. Work has been started on the lines, and will be pushed rapidly to completion. The company will connect at Tobyhanna with the Greentown and Gouldsboro lines, thus giving service from Stroudsburg to Lake Ariel and Hawley.

YONKERS, N. Y.—The Palisade Telephone Company has been incorporated, with a capital of $250,000. The company's lines are to be maintained from Yonkers to Mount Vernon, New Rochelle, Mamaroneck, Port Chester, White Plains, Hastings, Dobbs Ferry, Irvington, Tarrytown, Sing Sing, Peekskill and adjacent cities, towns and villages. The directors are Manning Merrill and Thomas T. Hill, of Brooklyn; George W. Romaine, William P. Catlin, A. T. Holbrook and George P. Dresher, of New York, and George B. Catlin, of East Orange, N. J.

New Electric Railways.

GLENS FALLS, N. Y.—The Warren County Railroad has been incorporated for the purpose of building an electric freight and passenger road from Warrensburg to Lake George, seven miles. The capital stock is $200,000; principal stockholders, ex-State Treasurer A. B. Colvin and J. M. Coolidge, of Glens Falls; J. A. Powers, of Lansingburg, and Congressman L. W. Emerson, of Warrensburg.

SAN FRANCISCO, CAL.—The Bay & Coast Railway Company has been incorporated for the purpose of operating railroads in San Francisco, San Mateo and Santa Cruz counties. The capital stock of the company is $3,000,000, of which $110,000 has been subscribed. The directors are L. H. Barnard, Thomas J. Sunny, James G. Hughes, H. Lacy and Michael J. Cochran.

LITTLE ROCK, ARK.—The Board of Railroad Incorporation has approved the charter of the Pine Bluff & Western Railway Company. The purpose of the corporation is to build a line of railway from Pine Bluff to Sheridan, in Grant County. The capital stock is $250,000. The board of directors consists of W. E. Sawyer and J. H. MacMillan, La Crosse, Wis.; E. L. Arnold, Minneapolis, Minn.; W. H. Langford, F. H. Head, Pine Bluff; T. F. Doyle, Sheridan. The length of the road will not exceed 25 miles.

WARREN, OHIO—The Mahoning Valley Traction Company has been incorporated, with a capital stock of $10,000. The incorporators, C. E. Sanders, Charles C. Owen, W. B. Whiting, William Duncan and A. N. Snyder. The proposed line is through Warren, Niles, Girard, Youngstown, Struthers and Lowellville.

ELWOOD, IND.—The new interurban street-car line from Alexandria to Elwood has been completed.

HARRISBURG, PA.—The East McKeesport Street Railway Company, to construct a street railway in the city of McKeesport, the distance to be about three and one-half miles, has been incorporated; capital stock, $25,000; directors, C. S. Mitchell, C. W. Leppert, John S. McFarland, W. J. Carson and Frank H. Clark.

BOSTON, MASS.—The new Georgetown, Rowley & Ipswich Street Railway Company has been incorporated, with a capital of $180,000. The line will run from the junction of Main and North streets, in Georgetown, through Newbury and Rowley to the Ipswich railroad station, with a branch from Dummer Academy, in Newbury, to Market square, in Newburyport; total, 18 miles. Among prominent incorporators are L. R. Hovey, Arthur Bishop, C. E. Barnes, W. B. Ferguson and J. F. Shaw & Company.

New Incorporations.

CHICAGO, ILL.—The Commercial Electric Company has been incorporated; capital stock, $10,000; incorporators, H. N. Rose, D. I. Sickelsteel and James R. Hastings.

CAMDEN, N. J.—The Mason Heating and Lighting Company, principal office, New Jersey Corporation Guarantee and Trust Company Building, has been incorporated; capital, $1,000,000; incorporators, James A. Mason, Ferdinand Bondheim, Albert E. Hartel, Clinton O. Mayer, William F. Eidell.

LITTLE ROCK, ARK.—The Brown Electric Company has been incorporated; George M. Heard, president; Milton Hill, secretary and treasurer. These with W. G. Brown constitute the board of directors. The capital stock is $30,000, of which $6,000 has been subscribed.

DU BOIS, PA.—The Du Bois Electric Company has been incorporated to supply light, heat and power; capital, $42,000; incorporators, J. E. Du Bois, F. W. Hetfield, W. Osborn, M. I. McCreigh, W. C. Pentz, all of Du Bois; S. W. Robinson, of Punxsutawney.

NEW BRUNSWICK, N. J.—The Raritan Electrical Manufacturing Company has been incorporated to manufacture electrical machines, tools, etc.; capital, $150,000; incorporators, Albert H. Gleason, Frederick N. Watris, W. Russell Osborn, all of New Brunswick, N. J.

JERSEY CITY, N. J.—The Butte Lighting and Power Company, principal office, the Corporation Trust Company's Building, has been incorporated to carry on electric lighting, heating and power business; capital, $1,000,000; incorporators, William J. Canning, William S. Brayton, Charles E. Estabrook, Christie P. Hamilton, Thomas K. Henderson.

LOS ANGELES, CAL.—The Pacific Wave Motor Company has been incorporated, with $1,000,000 capital, of which, it is claimed, $800,000 has been subscribed. The purpose of the company is to manufacture motors to be run by steam, electricity, compressed air or wave power.

CONROE, TEX.—The Conroe Communication Company has been incorporated; capital, $1,000; incorporators, A. E. Gilbert, C. H. Frazer, W. E. Gilbert and W. C. Conroe.

HICO, TEX.—The Hico Electric Light Company has been incorporated; capital stock, $1,600; incorporators, V. F. Wieser, J. F. Wieser and F. G. Wieser.

SPRINGFIELD, OHIO—The National Magnetic Electric Telegraph Company, for the purpose of building and operating telephone and telegraph lines and doing a general telegraphy business, has been incorporated; capital subscribed, $100,000, all of which is paid up.

Increase of Capital.

LEE, MASS.—The Lee Electric Company has petitioned for authority to increase its capital stock to $30,000 and its bonds to the same amount.

COLUMBUS, OHIO—The Cincinnati, Lawrenceburg & Aurora Electric Street Railway Company has increased its capital stock from $35,000 to $750,000. The incorporators are J. C. Hoover, George H. Helvey, F. D. Shaffer, C. L. Norren and Stanley Shaffer.

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"Hello, Central!" "What number, please?" "One thousand two hundred and sixty-four." "I don't catch that." "One thousand two hundred and sixty-four." "Try it once more, please." "Twelve hundred and sixty-four." "Seven hundred and sixty-four?" "No; twelve hundred and sixty-four—one thousand two hundred and sixty-four." "I can't give you two numbers at once. Which do you want first?" "I was giving you the same number two different ways." "A little louder, please. I can't quite make you out." "I said I was giving you the same number two different ways." "Oh, yes. Well, what number do you want?" "Twelve hundred and sixty-four." "Suppose you give me each figure separately, like one, two, three, for instance." "All right. One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve. Got that?" "Yes." "One, two, three, four, five, six. Got that?" "Yes." "One, two, three, four. Got that?" "Yes. You want twelve, six, four, do you?" "Yes; twelve hundred sixty-four. Do you understand now?" "Yes; I understand. Twelve-sixty-four is busy now. Ring off, please." —*Harper's Bazar.*

The electromobile never gets its tail over the reins in fly time.—*Chicago Times-Herald.*

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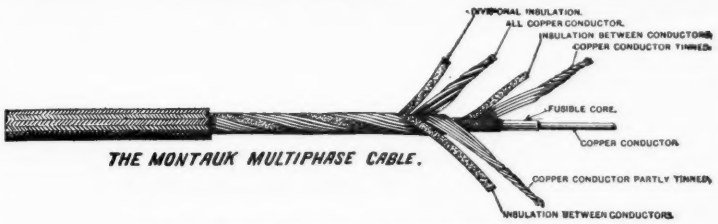

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STANDARD STREET FIXTURES

THESE Fixtures are furnished complete as shown in cuts, with 4-foot goose neck of ¾ pipe standard 16" hood 14½" deflector of heavy tin and of approved pattern. All castings of Malleable Iron.

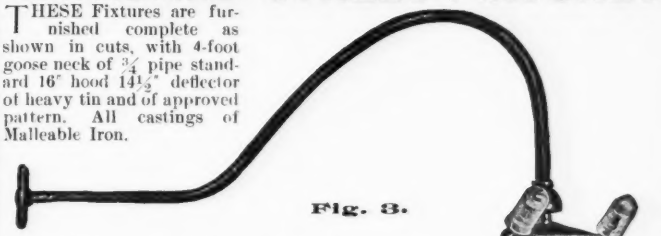

Fig. 3.

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Crocker-Wheeler's "Practical Management of Dynamos and Motors;" description and directions. Price..... 1 00
Buckley's "Electric Lighting Plants;" cost and operation. Price. 2 00
Crocker's "Electric Lighting;" for the use of electricians, students and others interested in the installation or operation of electric lighting plants. Price..... 3 00
Latimer's "Incandescent Electric Lighting;" a practical description of the Edison system. Price..... 50
Unwin's "Development and Transmission of Power from Central Stations;" a new and timely book. Price..... 3 50
Bell's "Electric Power Transmission;" a practical treatise for practical men. Price..... 2 50
Atkinson's "Elements of Electric Lighting." Price..... 1 50

ELECTRIC RAILWAY.

Perry's "Electric Railway Motors;" their construction, operation and maintenance. Price..... 1 00
Merrill's "Reference Book of Tables and Formulas for Electric Street Railway Engineers." Price..... 1 00
Trevert's "Electric Railway Engineering;" embracing practical hints upon power-house, dynamo, motor and line construction; for the use of students. Price..... 2 00

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Allsop's "Telephones: Their Construction and Fitting." Price..... 2 00
Hopkins's "Telephone Lines and Their Properties;" design and construction of city lines. Price..... 1 50
Poole's "Practical Telephone Hand-Book." New edition. Price... 1 50
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Preece & Stubb's "Manual of Telephony." Price..... 4 50
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Meadowcroft's "A B C of the X Rays." Price..... 75
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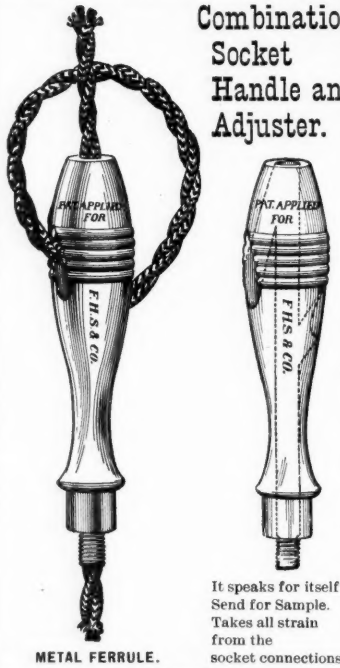

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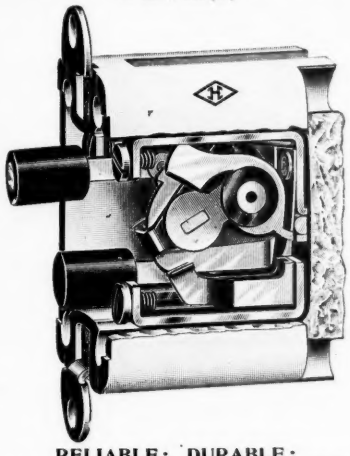

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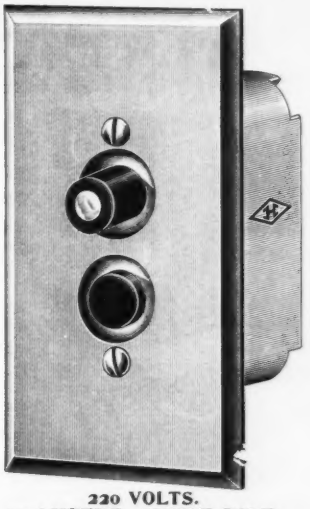

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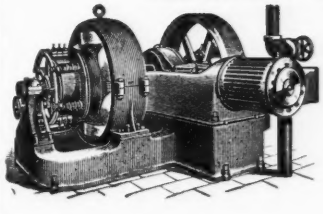

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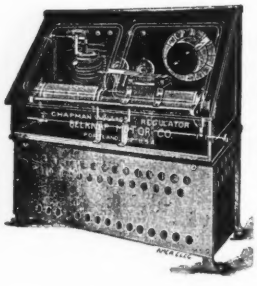

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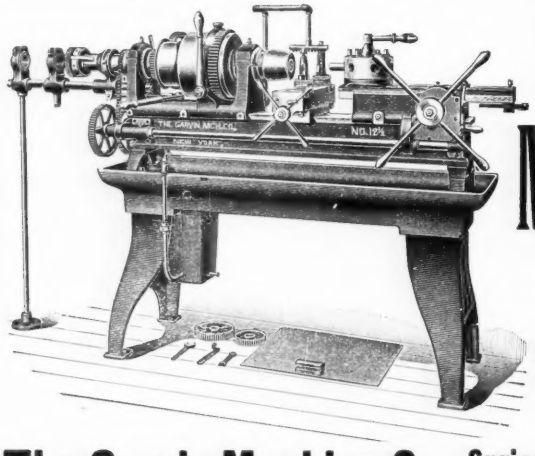

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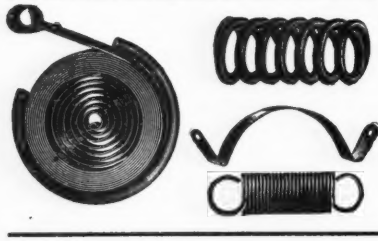

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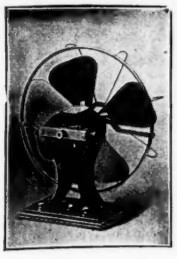

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Electrical Engineer Institute of Correspondence Instruction.
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Switches, Etc.
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Hart Mfg. Co.
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Large & Co.
Paiste Co., H. T.

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American Elec. Telephone Co.
Bunnell & Co., J. H.
Central Electric Co.
Central Telephone & Electric Co.
Connecticut Telephone & Electric Co.
Eureka Electric Co.
Farr Telephone and Construction Co.
Gordon, A. Y.
Mianus Electric Co.
Murdock & Co., Wm. J.
National Automatic Telephone Co.
New York Telephone Co.
North Electric Co.
Ohio Electric Works.
Reliable Electric Mfg. Co.
Standard Telephone & Electric Co.
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Stromberg-Carlson Telegraph Mfg. Co
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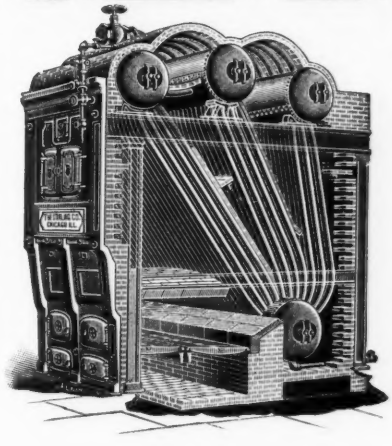

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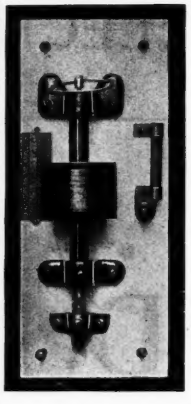

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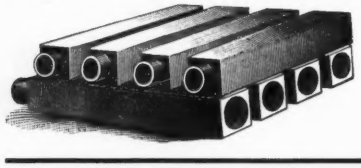

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